3D-SHAPER MEDICAL

PUBLICATIONS BOOKLET

APR 2023

3D-SHAPER Technology

DXA is a quick, painless and low-radiation dose imaging modality that provides 2D measurements of bone density. DXA does not however provide clinicians with a way to analyse and visualise bone in 3D to assess local fragilities in the cortical and trabecular compartments, nor can it effectively assess the efficacy of selected therapies longitudinally.

This is possible using Quantitative Computed Tomography (QCT), however QCT is significantly more expensive and time consuming, and exposes patients to much larger radiation doses. It is therefore not commonly used for this purpose.

But what if you could obtain 3D QCT-like results, from a standard 2D DXA image?

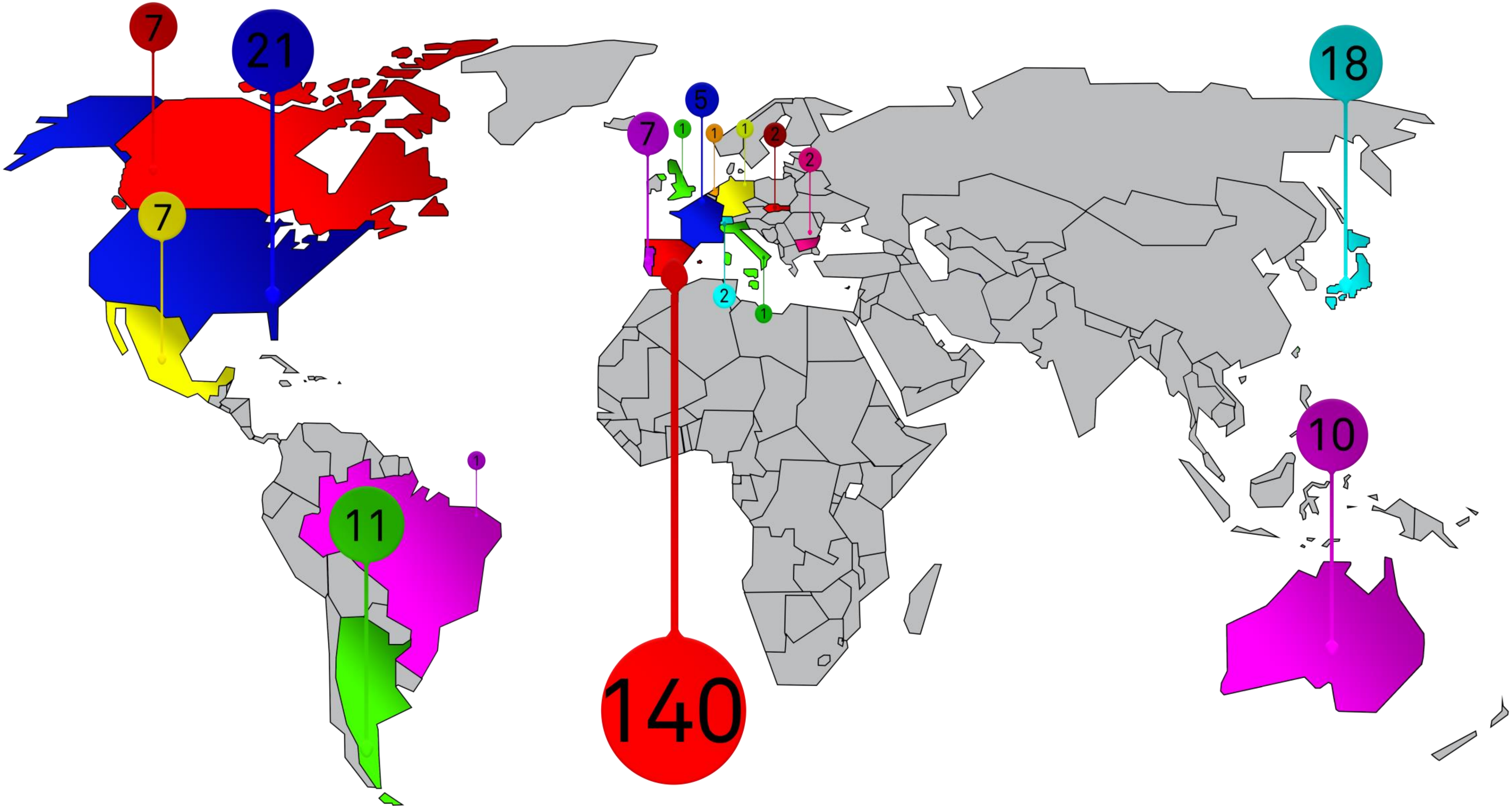
That means no extra radiation, no long scan time, and no hefty price tag!

Well, that's where 3D-Shaper comes in. 3D-Shaper uses advanced technology to transform a standard 2D DXA image into a patient-specific 3D QCT-like model, providing you with a fast, safe and cost-effective solution for visualising and assessing local changes in a patients Cortical and Trabecular bone.

Why is this important? Visualising compartments separately allows clinicians to assess the bone density in specific regions of the bone, and therefore identify where there are potential local fragilities. As therapies affect bone regions differently depending on their mode of action, 3D-Shaper enables clinicians to be highly selective when choosing to prescribe a therapy, whilst simultaneously providing evidence-based rationale to support decision making. Subsequent follow-ups will then allow for rapid monitoring and analysis of a therapy's effectiveness over time.

The following compilation of papers and posters represents the latest research into 3D-Shaper's software solution.

3D-SHAPER studies per country



A total of 237 studies*, 17 countries and 4 continents have used 3D-SHAPER technology

*Includes: Journal Publications, Conference Abstracts, Posters and Oral presentations

Table of Contents

Featured Studies

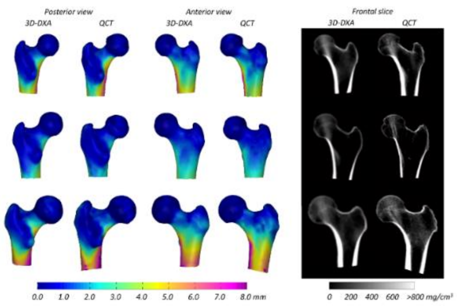
Technical & Validation

3D-Shaper's technology is being used worldwide to assess changes in the cortical, trabecular and integral bone compartments from a standard 2D DXA image. But how do we know this technique works? How accurate is it? And how valid are the results that are output from the software?

Well, it turns out that 3D-Shaper's statical modelling method is a highly accurate alternative to QCT and has achieved statistically significant correlations when compared against QCT imaging.

This section outlines some of the key studies highlighting the ***accuracy*** and ***validity*** of the 3D-Shaper technology.

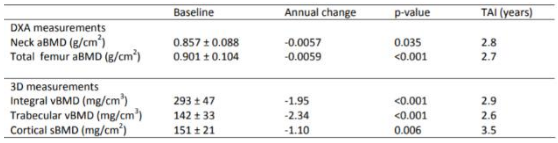
To date, there have been a total of 55 studies across 7 countries related to *'Technical & Validation'*:

KEY PUBLICATION				
STUDY	COHORT	OUTCOMES	RESULTS & VISUALIZATIONS	COUNTRY & AUTHORS
3D-DXA: Assessing the femoral shape the trabecular macrostructure and the cortex in 3D from DXA images. [2017] Available here	157 subjects; • 57 males • 100 females • Normal/Osteopenic/ Osteoporotic	3D-DXA technology is an accurate method to measure bone density distribution (cortical and trabecular compartments) from routine hip DXA scan, without adding scan/ radiation dose to the patient.	 Correlation coefficients*: integral vBMD: 0.95, trabecular vBMD: 0.86; cortical vBMD: 0.93; Mean cortical thickness: 0.91 *Calculated with first version without calibration between DXA models. Values recalculated with version 2.7.4: from 0.91 to 0.93	 Spain Humbert L, Martelli Y, Fonollà R, Steghöfer M, Di Gregorio S, Malouf J, Romera J, Del Río Barquero LM.

<table>
<tr><th>STUDY</th><th>COHORT</th><th>OUTCOMES</th><th>RESULTS & VISUALIZATIONS</th><th>COUNTRY & AUTHORS</th></tr>
<tr>
<td>3D Analysis of Cortical and Trabecular Bone from Hip DXA: Precision and Trend Assessment Interval in Postmenopausal Women.

[2019]

Available here</td>
<td>60 Subjects Precision Study:
• 48 Male
• 12 Female
• Over 50

53 Subjects Longitudinal Study:
• 53 Female</td>
<td>Trend Assessment Intervals in postmenopausal women were similar to those measured for aBMD measurements. DXA-derived 3D measurements could potentially provide additional indicators to improve patient monitoring in clinical practices.</td>
<td>
<table>
<tr><th></th><th>Baseline</th><th>Annual change</th><th>p-value</th><th>TAI (years)</th></tr>
<tr><td>DXA measurements</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Neck aBMD (g/cm^2)</td><td>0.857 ± 0.088</td><td>-0.0057</td><td>0.035</td><td>2.8</td></tr>
<tr><td>Total femur aBMD (g/cm^2)</td><td>0.901 ± 0.104</td><td>-0.0059</td><td><0.001</td><td>2.7</td></tr>
<tr><td>3D measurements</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Integral vBMD (mg/cm^3)</td><td>293 ± 47</td><td>-1.95</td><td><0.001</td><td>2.9</td></tr>
<tr><td>Trabecular vBMD (mg/cm^3)</td><td>142 ± 33</td><td>-2.34</td><td><0.001</td><td>2.6</td></tr>
<tr><td>Cortical sBMD (mg/cm^2)</td><td>151 ± 21</td><td>-1.10</td><td>0.006</td><td>3.5</td></tr>
</table>

Least significant changes were 10.39 and 8.72 mg/cm3 for integral volumetric BMD, 9.64 and 9.59 mg/cm3 for trabecular volumetric BMD and 6.25 and 5.99 mg/cm2 for cortical surface BMD.

Trend assessment intervals in postmenopausal women were 2.9 years (integral volumetric BMD), 2.6 years (trabecular volumetric BMD) and 3.5 years (cortical surface BMD) As a comparison, trend assessment intervals for aBMD were 2.8 years at neck, and 2.7 years at total femur.</td>
<td>
Spain

Humbert L,
Winzenrieth R,
Di Gregorio S,
Thomas T,
Vico L,
Malouf J,
del Río L.</td>
</tr>
<tr>
<td>3D patient-specific finite element models of the proximal femur based on DXA towards the classification of fracture and non-fracture cases.

[2019]

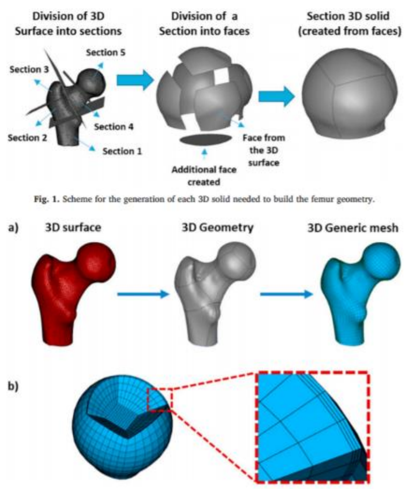
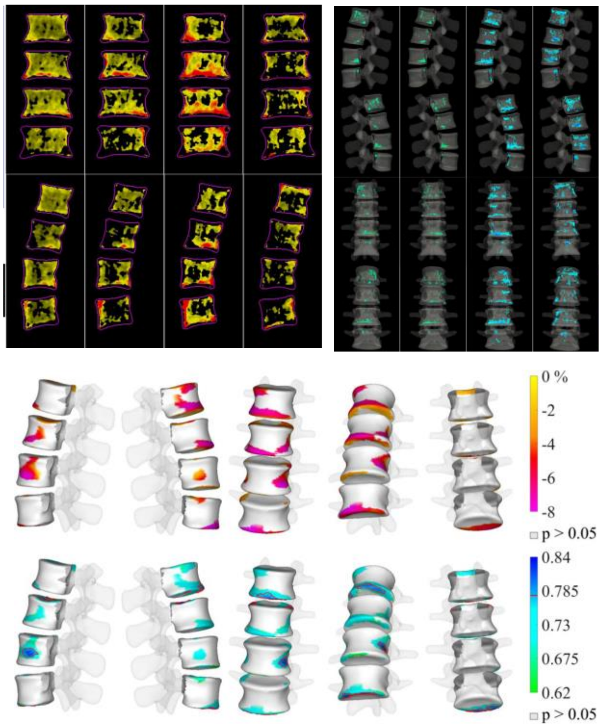
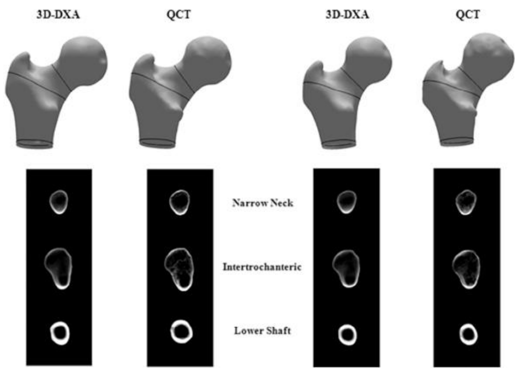
Available here</td>
<td>111 Subject 2 groups:
• 62 fracture cases
• 49 non-fracture control</td>
<td>3D FE models derived from DXA scans might significantly improve the prediction of hip fracture risk; providing a new insight for clinicians to use FE simulations in clinical practice for osteoporosis management.</td>
<td>

Fig. 1. Scheme for the generation of each 3D solid needed to build the femur geometry.

• The major principal stress was better discriminator (AUC > 0.80) than the volumetric BMD (AUC ≤ 0.70).
• High discrimination capacity was achieved when the analysis was performed by bone type, zone of fracture and gender/sex.
• Outcomes suggested that the trabecular bone is critical for fracture discrimination.</td>
<td>
Spain

Ruiz Wills C,
Olivares AL,
Tassani S,
Ceresa M,
Zimmer V,
González Ballester MA,
Del Río LM,
Humbert L,
Noailly J.</td>
</tr>
</table>

STUDY	COHORT	OUTCOMES	RESULTS & VISUALIZATIONS	COUNTRY & AUTHORS
Discrimination of osteoporosis-related vertebral fractures by DXA-derived 3D measurements: a retrospective case-control study. [2019] Available here	74 postmenopausal women: • 37 with incident vertebral fractures and • 37 age-matched controls without any type of fracture	Trabecular vBMD was the measurement that best discriminates between fracture and control groups: AUC of 0.733 against 0.682 for aBMD. This study showed the ability of cortical and trabecular measurements from DXA-derived 3D models to discriminate between fracture and control groups.	 Images showing: Average trabecular vBMD changes and AUC map, and average differences in cortical sBMD and AUC map.	 Spain López Picazo M, Humbert L, Di Gregorio S, González Ballester MA, Del Río Barquero LM.
Structural Parameters of the Proximal Femur by 3-Dimensional Dual-Energy X-ray Absorptiometry Software: Comparison With Quantitative Computed Tomography. [2018] Available here	60 subjects with DXA and QCT	Our study demonstrated that accurate estimates of structural parameters for the femur can be obtained from 3D-DXA models. This provides clinicians with 3D indexes related to the femoral strength from routine anteroposterior DXA scans, which could potentially improve osteoporosis management and fracture prevention.	 Correlation coefficients were: • 0.86 for the femoral neck axis length • 0.71 for the femoral neck shaft angle. • From 0.86 to 0.96 for the cross-sectional parameters • From 0.84 to 0.97 for the volumetric structural parameters	 Spain Clotet J, Martelli Y, Di Gregorio S, Del Río Barquero LM, Humbert L.

Association with Fracture

DXA, known for its ability to assess areal Bone Mineral Density and provide clinicians with a T-Score to support the subsequent diagnosis of Osteoporosis, low BMD or normal BMD. This information is widely used, amongst other factors, to help indicate a person's risk of sustaining a fracture.

3D-Shaper takes this one step further by exploring the bone in full 3D and proving clinicians with quantitative, patient-specific measurements for Cortical, Trabecular and Integral bone.

But how are these values associated with fracture? What clinical significance can they provide?

This section outlines a few key studies that have researched exactly this, identifying how 3D-Shaper can ***support clinical decision making*** and identify patients at risk.

To date, there have been a total of 38 studies across 5 countries related to 'Association with Fracture':

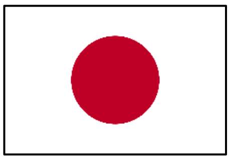
<table>
<tr><th colspan="5">KEY PUBLICATION</th></tr>
<tr><th>STUDY</th><th>COHORT</th><th>OUTCOMES</th><th>RESULTS & VISUALIZATIONS</th><th>COUNTRY & AUTHORS</th></tr>
<tr>
<td>Predictive ability of novel volumetric and geometric indices derived from dual-energy X-ray absorptiometric images of the proximal femur for hip fracture compared with conventional areal bone mineral density: the Japanese Population-based Osteoporosis (JPOS) Cohort Study.

[2021]

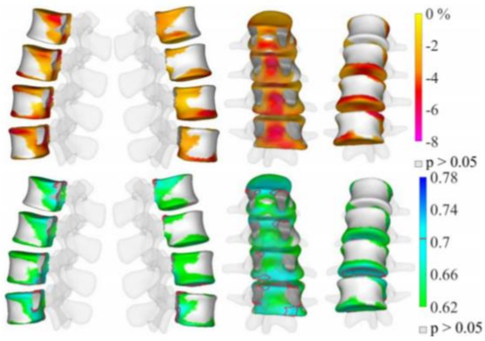
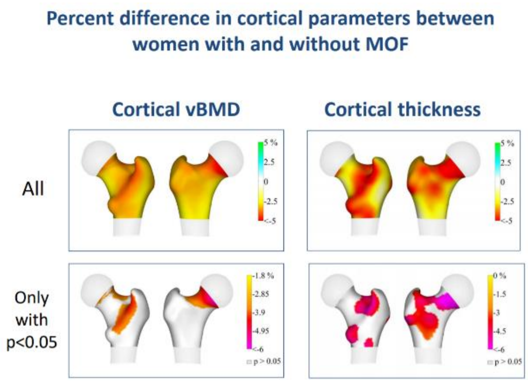
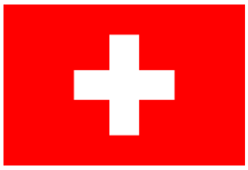
Available here</td>
<td>1331 Women

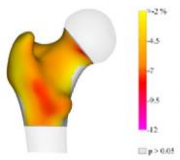
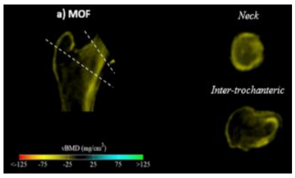
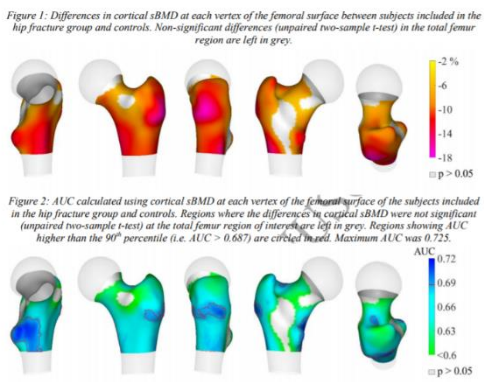
Age 40–79 years at baseline

Baseline survey & at least one follow-up survey over 20 years</td>
<td>vBMD obtained from 3D modeling using routinely obtained hip DXA images significantly improved hip fracture risk prediction over conventional Femoral Neck aBMD, but not Total Hip aBMD.</td>
<td>
<table>
<tr><th></th><th>Unadjusted</th><th></th><th>Age-adjusted</th><th></th><th>Multivariate-adjustedA</th><th></th></tr>
<tr><th>Predictor</th><th>HR</th><th>(95% CI)</th><th>HR</th><th>(95% CI)</th><th>HR</th><th>(95% CI)</th></tr>
<tr><td>aBMD</td><td></td><td></td><td></td><td></td><td>-</td><td>-</td></tr>
<tr><td>FN-aBMD</td><td>3,33</td><td>(2.54, 4.39)</td><td>1,8</td><td>(1.29, 2.52)</td><td>-</td><td>-</td></tr>
<tr><td>TH-aBMD</td><td>3,34</td><td>(2.64, 4.26)</td><td>2,02</td><td>(1.49, 2.74)</td><td>-</td><td>-</td></tr>
<tr><td colspan="7">Volumetric indices</td></tr>
<tr><td>TH-TvBMD</td><td>5,03</td><td>(3.58, 7.04)</td><td>2,90</td><td>(1.92, 4.37)</td><td>3,17</td><td>(1.75, 5.75)</td></tr>
<tr><td>FN-TvBMD</td><td>5,18</td><td>(3.64, 7.41)</td><td>2,92</td><td>(1.89, 4.48)</td><td>3,55</td><td>(1.74, 7.25)</td></tr>
<tr><td>IT-TvBMD</td><td>4,44</td><td>(3.28, 6.02)</td><td>2,68</td><td>(1.86, 3.86)</td><td>3,11</td><td>(1.82, 5.29)</td></tr>
<tr><td>IT-CvBMD</td><td>3,03</td><td>(2.31, 3.98)</td><td>1,75</td><td>(1.27, 2.40)</td><td>1,55</td><td>(1.03, 2.31)</td></tr>
<tr><td>TH-CsBMD</td><td>3,32</td><td>(2.53, 4.37)</td><td>1,91</td><td>(1.38, 2.63)</td><td>1,85</td><td>(1.11, 3.07)</td></tr>
<tr><td>IT-CsBMD</td><td>3,41</td><td>(2.56, 4.55)</td><td>1,91</td><td>(1.37, 2.66)</td><td>1,81</td><td>(1.06, 3.09)</td></tr>
<tr><td colspan="7">Geometric indices</td></tr>
<tr><td>FN-CSA</td><td>4,08</td><td>(2.99, 5.59)</td><td>2,23</td><td>(1.54, 3.22)</td><td>2,38</td><td>(1.19, 4.76)</td></tr>
<tr><td>IT-CSA</td><td>4,27</td><td>(3.14, 5.81)</td><td>2,45</td><td>(1.69, 3.55)</td><td>3,13</td><td>(1.68, 5.81)</td></tr>
<tr><td>IT-Z</td><td>3,45</td><td>(2.58, 4.59)</td><td>1,99</td><td>(1.44, 2.74)</td><td>1,85</td><td>(1.21, 2.82)</td></tr>
<tr><td>IT-BR[C]</td><td>2,47</td><td>(2.07, 2.93)</td><td>1,68</td><td>(1.35, 2.08)</td><td>1,61</td><td>(1.19, 2.18)</td></tr>
</table>

• A significantly larger AUC of trabecular volumetric BMD (vBMD) at the total hip (AUC = 0.741), femoral neck (AUC = 0.748), and intertrochanter (AUC = 0.738) and significant NRI (0.177, 0.149, and 0.195, respectively) were observed compared with FN-aBMD (AUC = 0.701), but not TH-aBMD.
</td>
<td>
Japan

Iki M, Winzenrieth R, Tamaki J, Sato Y, Dongmei N, Kajita E, Kouda K, Yura A, Tachiki T, Kamiya K, Kagamimori S.</td>
</tr>
</table>

STUDY	COHORT	OUTCOMES	RESULTS & VISUALIZATIONS	COUNTRY & AUTHORS
Association between osteoporotic femoral neck fractures and DXA-derived 3D measurements at lumbar spine: a case-control study. [2020] Available here	61 women with transcervical hip fractures 61 age-matched women without any type of fracture	This study showed the association of DXA-derived measurements at lumbar spine with transcervical hip fractures. A strong association between vBMD at the posterior vertebral elements and transcervical hip fractures was observed, probably because of global deterioration of the cortical bone .	 • Integral vBMD, cortical vBMD, cortical sBMD, and cortical thickness were the DXA-derived 3D measurements at lumbar spine that showed the stronger association with transcervical hip fractures • The highest AUC (0.726) and OR (2.610) at the lumbar spine were found for integral vBMD at the posterior vertebral elements. Significantly, lower AUC (0.617) and OR (1.607) were found for trabecular vBMD at the vertebral body.	 Spain López Picazo M, Humbert L, Winzenrieth R, Di Gregorio S, González Ballester MA, Del Río Barquero LM.
DXA-based 3D mapping of hip cortical thinning correlates with incident fractures in postmenopausal women from the GERICO cohort. [2019] Available here	796 Postmenopausal women at baseline. Follow-up 5.7 ± 1.5 yrs. 100 women (13%) with lowtrauma clinical fracture, 44 with MOF	DXA-based 3D modeling parameters are associated with all types and major osteoporotic fractures The associations of trabecular vBMD with fractures are of greater magnitude than those of the cortical parameters.	 • Predicting incidence of low-trauma fractures: Risk increased by 23-40% • Prediction of MOF: Risk increased by 36-63%	 Switzerland Biver E, Hars M, Winzenrieth R, Rizzoli R, Ferrari S.

STUDY	COHORT	OUTCOMES	RESULTS & VISUALIZATIONS	COUNTRY & AUTHORS
Cortical and trabecular bone of patients with prevalent major osteoporotic fracture: a case-control study using DXA-based 3D modelling. [2018] Available here	1,848 women from 50, including 105 fractured individuals (MOF)	The authors concluded that the trabecular volumetric BMD is the strongest parameter to discriminate fractured from non-fractured individual, and that assessing 3D bone parameters could be useful for fracture discrimination in clinical practice	  Spine aBMD, Total Femur aBMD and all 3D measurements significantly lower in fractured subjects (fx); Adjusted for age: only TF aBMD & trabecular vBMD remain significant discriminating factors for fx adjusted for age and weight, trabecular vBMD remains the only significant discriminator of fx	 USA Winzenrieth R, Humbert L, Leib E.
DXA-Based 3D Analysis of the Cortical and Trabecular Bone of Hip Fracture Postmenopausal Women: A Case-Control Study. [2018] Available here	• 64 hip fracture post-menopausal women • 64 controls	This case-control study showed the association of DXA-derived 3D measurements with hip fracture. Hip fracture group had lower cortical sBMD and trabecular vBMD, compared to controls	 • Total hip aBMD of hip fracture group as measured by DXA was 10.7% lower compared to control group. • Differences in vBMD were more pronounced in the trabecular compartment (-23.3%) than in the cortex (-8.2%). • Differences in the cortex more pronounced at the medial aspect of the shaft, the lateral aspect of the greater trochanter, and the superolateral aspect of the neck.	 Spain Humbert L, Bagué A, Di Gregorio S, Winzenrieth R, Sevillano X, González Ballester MÁ, Del Rio L.

Treatment Monitoring

The effect of various pharmacological agents on bone health and density is well known regarding the specific impact to Bone Mineral Density as assessed with DXA, and many with specific regional changes as assessed by QCT. But QCT is not routinely used clinically as it's expensive, time consuming and exposes patients to large doses of radiation. In research, the problems with QCT are the same: exposing patients to large radiation doses, higher research costs and difficult image acquisition.

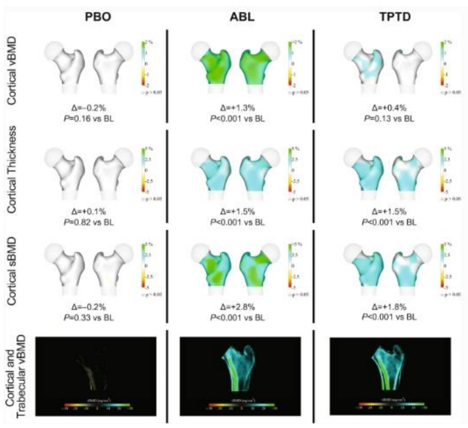
Using 3D-Shaper, researchers and clinicians now have the ability to review the impact of specific therapies on each bone compartment, without the need for QCT or alternative imaging methods;

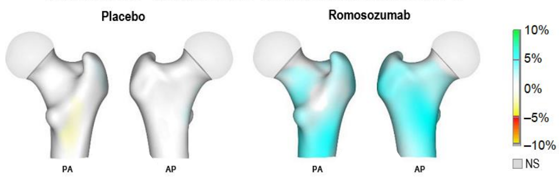
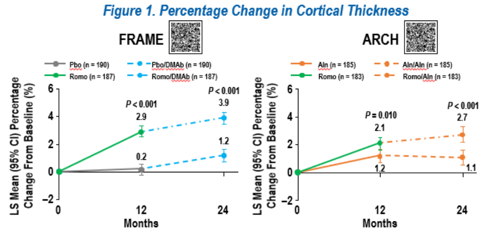
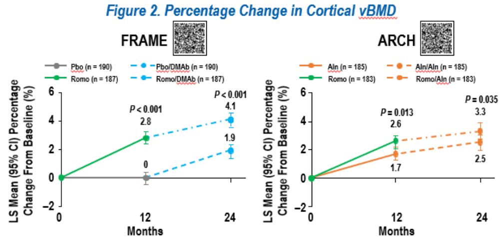
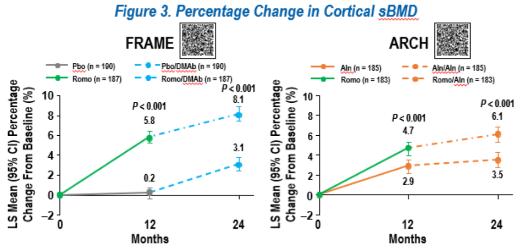
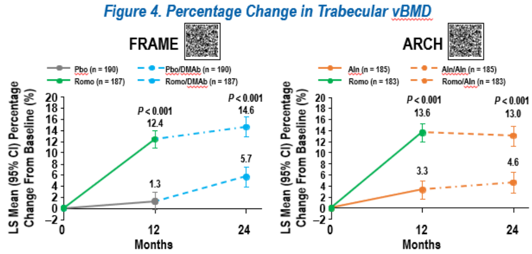
3D-Shaper completely simplifies the longitudinal monitoring of patients.

Below are some of the recent highlights and key projects using 3D-Shaper for this purpose.

To date, there have been a total of 50 studies across 6 countries related to 'Treatment Monitoring'

KEY PUBLICATION

STUDY	COHORT	OUTCOMES	RESULTS & VISUALIZATIONS	COUNTRY & AUTHORS
Differential effects of abaloparatide and teriparatide on hip cortical volumetric BMD by DXA-based 3D modeling. [2021] Available here	750 patients 3 treatment arms: • 250 ABL • 250 TPTD • 250 Placebo	Similar significant increases in trabecular volumetric BMD (vBMD, + 9%) and cortical thickness (+ 1.5%) were observed with ABL and TPTD by 3D-DXA at 18 months. In contrast, only ABL significantly increased cortical vBMD versus baseline (+ 1.3%), and changes in both cortical vBMD and cortical surface BMD were significantly greater with ABL versus TPTD.	 Spatial changes in 3D-DXA cortical endpoints and cross-sectional representations of spatial changes in vBMD at month 18. Increases in cortical sBMD, cortical vBMD, and cortical thickness are presented in blue-green colors while decreases are presented in yellow-red colors.	 USA Winzenrieth R, Ominsky MS, Wang Y, Humbert L, Weiss RJ.

STUDY	COHORT	OUTCOMES	RESULTS & VISUALIZATIONS	COUNTRY & AUTHORS
Cortical and Trabecular Bone improvements with Romosozumab followed by Denosumab or Alendronate assessed using 3D Modeling from DXA images. [2022] Abstract not currently Available	377 patients in FRAME • 190 women PBO • 187 women ROMO 368 patients in ARCH • 185 women ALN • 183 women ROMO	3D-SHAPER analysis provides an alternative to QCT to estimate changes in cortical and trabecular parameters from standard DXA images. Results from the 3D-SHAPER analysis of FRAME and ARCH complement extensive evidence demonstrating that treatment with ROMO results in substantial gains in hip cortical and trabecular bone compartments within 1 year, and that transition to an antiresorptive can maintain or augment those gains. Supports evidence that patients at high risk for fracture may benefit from treatment with romosozumab first, followed by an antiresorptive.	Example: FRAME – Change in Cortical Thickness From Baseline to Month 12  Figure 1. Percentage Change in Cortical Thickness  Figure 2. Percentage Change in Cortical vBMD  Figure 3. Percentage Change in Cortical sBMD  Figure 4. Percentage Change in Trabecular vBMD  At month 12, treatment with ROMO vs PBO in FRAME and ROMO vs ALN in ARCH resulted in significantly greater increases with ROMO in cortical thickness, cortical vBMD, cortical sBMD, and trabecular vBMD. At month 24, culmative gains in these parameters remained significantly greater in ROMO-DMAB and ROMO-ALN switch groups when compared against ROMO-PBO and ALN-ALN groups.	 USA M. Lewiecki, D. Betah, L. Humbert, C. Libanati, M. Oates, Y. Shi, R.Winzenrieth, S. Ferrari, F. Omura.

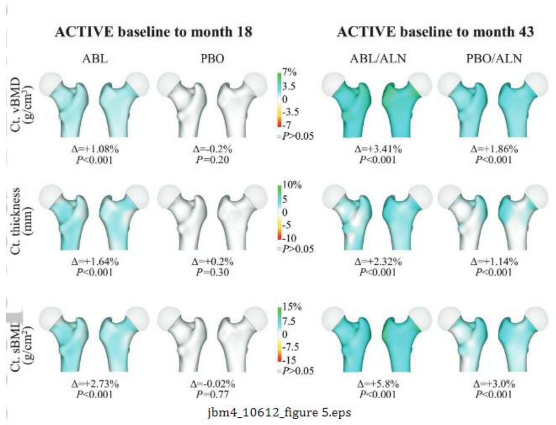
<table>
<tr><th>STUDY</th><th>COHORT</th><th>OUTCOMES</th><th>RESULTS & VISUALIZATIONS</th><th>COUNTRY & AUTHORS</th></tr>
<tr>
<td>Proximal Femur Responses to Sequential Therapy with Abaloparatide Followed by Alendronate in Postmenopausal Women with Osteoporosis by 3D Modeling of Hip DXA.

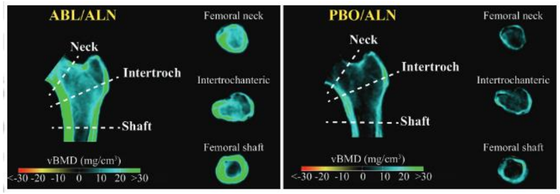
[2022]

Available here</td>
<td>406 patients

2 treatment arms:
• 204 ABL/ALN
• 202 PBO/ALN</td>
<td>These results, which are among the first to describe skeletal responses to alendronate after treatment with a PTHR1 agonist that is currently approved for the treatment of PMO, indicate significant improvements in aBMD, Ct.vBMD, and Tb.vBMD of the total hip and hip subregions with ABL/ALN versus PBO/ALN.

For most 2D-DXA and 3D-DXA parameters, particularly the cortical measures, alendronate effects were relatively similar whether alendronate was administered after abaloparatide or after placebo.

These results support the use of abaloparatide as the initial treatment in sequential therapy with alendronate in women with PMO at very high fracture risk.</td>
<td>

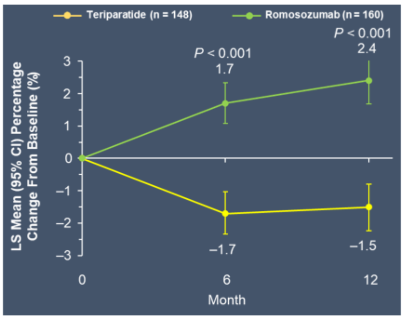
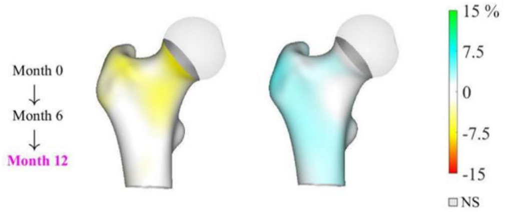
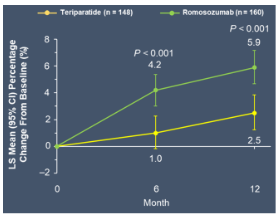
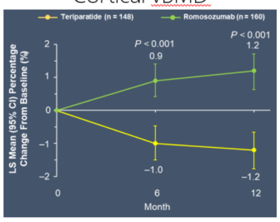
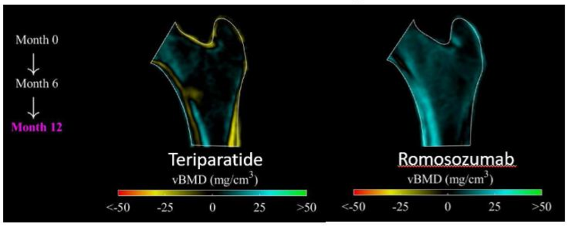


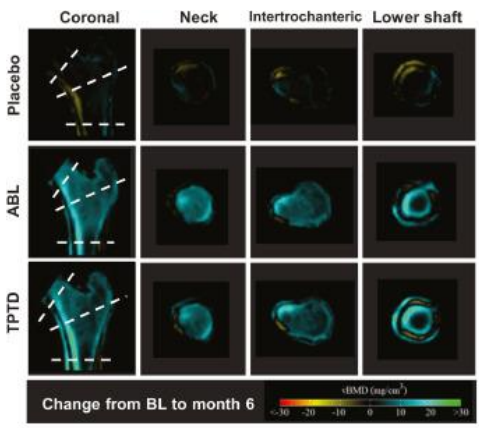
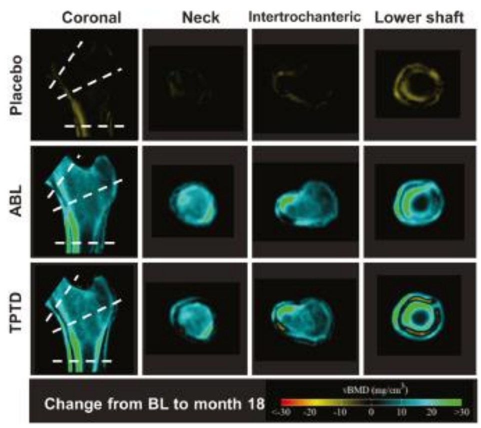
Cross- Total hip trabecular and cortical 3D-DXA parameters increased from baseline in both groups (all P<0.001), with greater average increases for ABL/ALN versus PBO/ALN (trabecular vBMD: 10.87% vs 4.3%; Cortical thickness: 2.32% vs 1.14%; Ct.vBMD: 3.41% vs 1.86%; cortical surface BMD: 5.82% vs 3.0%; all P<0.001).

Strength indices in the ABL/ALN group improved in all subregions versus baseline (all P<0.0001) and versus PBO/ALN (all P<0.02).

In the ABL/ALN group, collagen type I N-terminal propeptide (PINP) levels at the time of alendronate initiation correlated with subsequent percent changes in all 3D-DXA parameters with 24 months of alendronate therapy.</td>
<td>USA

R.Winzenrieth, P.Kostenuik J.I.Boxberger, Y.Wang, L.Humbert</td>
</tr>
</table>

STUDY	COHORT	OUTCOMES	RESULTS & VISUALIZATIONS	COUNTRY & AUTHORS
Comparison of Romosozumab and Teriparatide effects on Cortical and Trabecular bone using 3D Modeling from DXA images in Postmenopausal women transitioning from Bisphosphonate Therapy. [2022] Abstract not currently Available	Women from the STRUCTURE phase 3 clinical trial. 308 Postmenopausal women 2 treatment arms: • 148 TPTD • 160 ROMO	Use of DXA-based 3D modeling by 3D-SHAPER analysis allowed advanced assessment of the cortical and trabecular bone changes using standard hip DXA scans. 3D-SHAPER analysis provides an alternative to QCT to derive useful cortical and trabecular parameters from standard DXA images	Cortical sBMD  Distribution of changes  Trabecular vBMD  Cortical vBMD  Distribution of changes  Results obtained by DXA-based 3D modeling were consistent with results obtained by QCT in STRUCTURE for cortical vBMD but not for trabecular vBMD. Both DXA-based 3D modeling and QCT showed increases in cortical vBMD with romosozumab and loss with teriparatide, with the difference between the two treatments reaching statistical significance for both methods. Both DXA-based 3D modeling and QCT showed greater increases in trabecular vBMD with romosozumab vs teriparatide; however, gains were statistically greater with DXA-based 3D modeling, but not with QCT.	 USA M. Lewiecki, D. Betah, L. Humbert, C. Libanati, M. Oates, Y. Shi, R.Winzenrieth, S. Ferrari, F. Omura.

STUDY	COHORT	OUTCOMES	RESULTS & VISUALIZATIONS	COUNTRY & AUTHORS
Abaloparatide Effects on Cortical Volumetric BMD and Estimated Strength Indices of Hip Subregions by 3D-DXA in Women with Postmenopausal Osteoporosis. [2021] Available here	750 patients 3 treatment arms: • 250 ABL • 250 TPTD • 250 Placebo	3D-DXA show that 6 and 18 mo of ABL or TPTD similarly increased Tb.vBMD at the femoral neck, trochanter, and femoral shaft vs baseline and PBO, whereas the ABL group showed greater increases in Ct.vBMD vs TPTD and PBO at mo 18 for all 3 hip subregions of interest. Cortical thickness of the femoral neck, intertrochanteric, and shaft regions was similarly increased with ABL and TPTD, and Ct.sBMD of the femoral neck and intertrochanteric subregions showed greater increases at mo 18 with ABL than TPTD.	  Cross-sectional views depicting average vBMD changes at months 6 and 18 for each group. Data reflect absolute vBMD changes from baseline. Blue/green represents increased vBMD, yellow/orange represents decreased vBMD, black represents no change. Central compartments (FN & intertrochanteric slices) are noticeably bluer at mo 6 & 18 in ABL and TPTD examples vs PBO (consistent with observed treatment effects of ABL and TPTD on Tb.vBMD). The outermost peripheral aspects of the FN & shaft appear blue and green in ABL & TPTD groups, especially at mo 18 (consistent with observed increases from baseline in Ct.vBMD). Yellow rings are evident within the femoral shaft of the ABL & TPTD groups at mo 6 (may reflect reductions in vBMD of the deep cortex). Reduced vBMD remains evident at mo 18 with TPTD but not with ABL.	 USA R.Winzenrieth, L.Humbert, J.I.Boxberger, R.J.Weiss, Y.Wang, P.Kostenuik

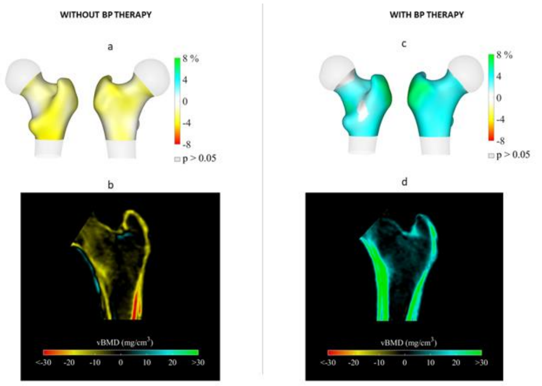
<table>
<tr><th>STUDY</th><th>COHORT</th><th>OUTCOMES</th><th>RESULTS & VISUALIZATIONS</th><th>COUNTRY & AUTHORS</th></tr>
<tr>
<td>Trabecular and cortical bone health in postmenopausal women receiving aromatase inhibitors for early breast cancer treatment: The B-ABLE prospective cohort study.

[2019]

Available here</td>
<td>464 women

366 with bisphospho-nates (BP+)

98 without bisph. (BP-)

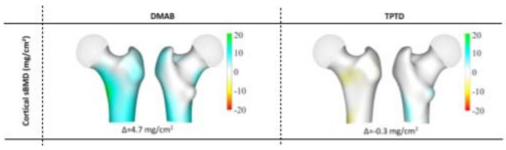
bone evaluation by DXA at baseline, 12 and 24 months</td>
<td>This study highlights the possibility to better manage patients with early breast cancer in terms of bone assessment, monitoring, and treatment recommendation.</td>
<td>

• AI impaired both trabecular and cortical compartments in BP- subjects while BP compensate for the deleterious AI effects on bone;
• Consistently with aBMD at spine, BP- had a more marked decrease of the trabecular compartment at femur;

3D analysis showed that BP protective treatment stops to overcome the negative effect of AI on trabecular bone after 12 months, suggesting a possible decrease of the trabecular bone after 24 months of AI.</td>
<td>
Spain

Nogués X,
Rodriguez R,
Rodríguez-Sanz M,
Winzenrieth R,
Humbert L,
Pineda-Moncusí M,
Servitja S,
Garcia-Giralt N,
Martos T,
Tusquets I,
Martínez-García M,
Rodríguez Morera R,
A Dies Perez,
Albanell J.</td>
</tr>
<tr>
<td>Effects of osteoporosis drug treatments on cortical and trabecular bone in the femur using DXA-based 3D modelling.

[2018]

Available here</td>
<td>155 subjects;
• 16 males
139 females</td>
<td>This study highlights the possibility and added value to monitor TTT effects through a 3D analysis, as TTTs have different effects at the cortical and trabecular compartments. Such analysis required, until now, the use of QCT (cost+radiation↗) and is now possible from DXA</td>
<td>
<table>
<tr><th></th><th>NAIVE</th><th>AL</th><th>DMAB</th><th>TPTD</th></tr>
<tr><td>Trabecular vBMD (mg/cm³)</td><td>–</td><td>+</td><td>++</td><td>++</td></tr>
<tr><td>Cortical sBMD (mg/cm²)</td><td>–</td><td>+</td><td>++</td><td>=</td></tr>
<tr><td>Cth (mm)</td><td>=</td><td>=</td><td>+</td><td>+</td></tr>
<tr><td>Cortical vBMD (mg/cm³)</td><td>=</td><td>+</td><td>+</td><td>–</td></tr>
</table>

</td>
<td>
Spain

Winzenrieth R,
Humbert L,
Di Gregorio S,
Bonel E,
García M,
Del Rio LM</td>
</tr>
</table>

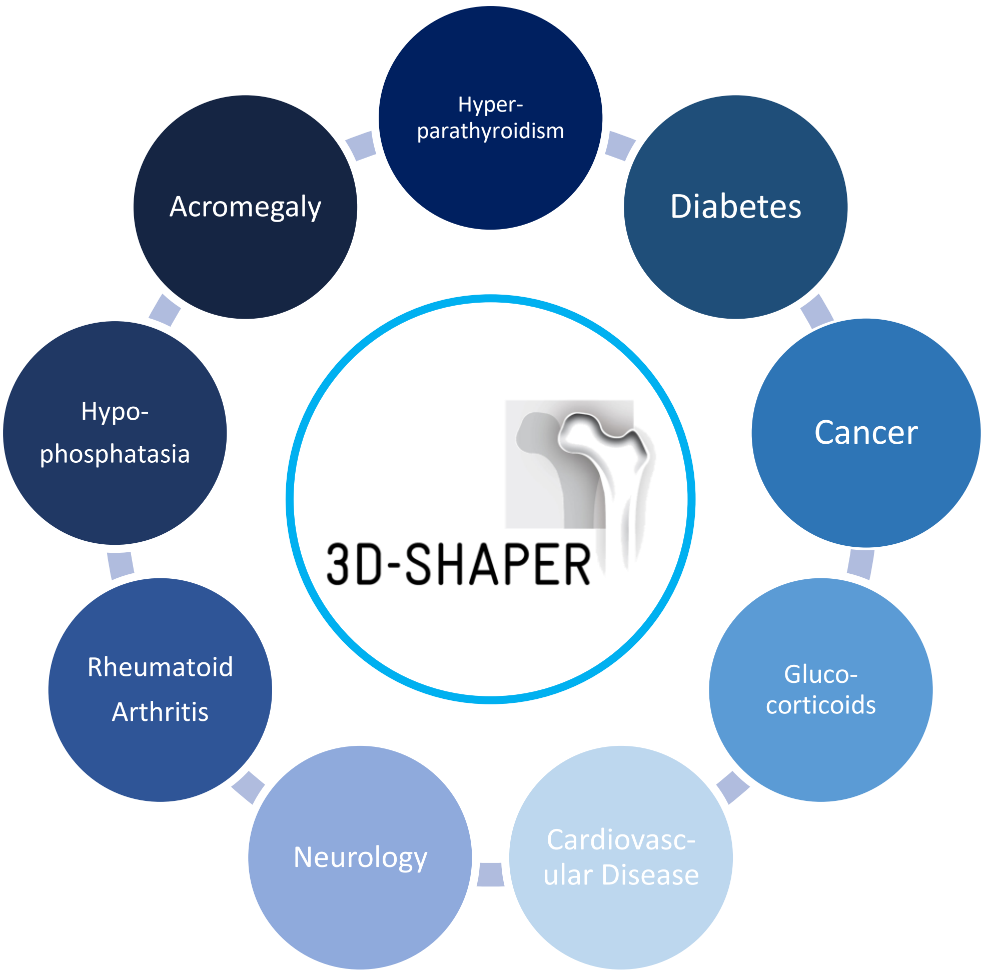
Secondary Osteoporosis

Secondary Osteoporosis is defined as low bone mass with microarchitectural alterations in bone leading to fragility fractures in the presence of an underlying disease or medication. This topic has been attracting a lot of attention globally and researchers have been doing a fantastic job looking into how these diseases/ medications are impacting bone density and what we can do to limit and stop them.

3D-Shaper has been playing a pivotal role by providing researchers with a tool to explore their data in a way only previously possible with QCT. Now, with a standard 2D-DXA image, researchers can ***visualise bone impact in full 3D***, ***assess local fragilities*** and ***monitor*** how each bone compartment is impacted over time.

Below outlines a few key studies exploring the effects of secondary osteoporosis.

To date, there have been a total of 76 studies across 13 countries related to '*Secondary Osteoporosis*



Hyperparathyroidism

STUDY	COHORT	OUTCOMES	RESULTS & VISUALIZATIONS	COUNTRY & AUTHORS

STUDY: Analysis of Bone Impairment by 3D DXA Hip Measures in Patients With Primary Hyperparathyroidism: A Pilot Study.

[2020]

Available here

COHORT: 80 adults (59.5 ± 9.1 yrs)

- 40 with PHPT
- 40 age- and sex-matched healthy controls.

OUTCOMES: The trabecular bone is relatively preserved while cortical bone is largely affected.

Patients with PHPT and diagnosed with osteoporosis or osteopenia had significantly lower cortical vBMD compared with those who had normal bone values.

3D-DXA findings are consistent with those reported in studies using HRpQCT.

RESULTS & VISUALIZATIONS:

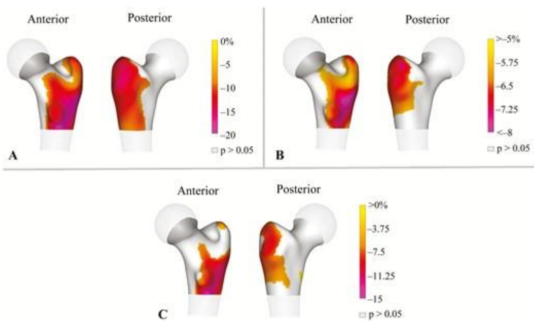


Table 2. Mean-Adjusted (by Age, Sex, and Body Mass Index) Differences in Areal Bone Mineral Density (aBMD) and 3D-DXA Parameters Between the Study Groups

	Primary Hyperparathyroidism (n = 40)		Controls (n = 40)			
	Mean	95% CI	Mean	95% CI	P	Effect Size[¥]
aBMD (g/cm²)						
Femoral neck	0.695	0.664 – 0.726	0.747	0.716 – 0.778	**0.023**	0.51
Trochanter	0.610	0.585 – 0.635	0.672	0.647 – 0.697	**0.001**	0.75
Shaft	0.989	0.950 – 1.028	1.105	1.066 – 1.144	**<0.001**	0.91
Total hip	0.838	0.807 – 0.869	0.940	0.909 – 0.971	**<0.001**	1.01
3D-DXA						
Cortical sBMD (mg/cm²)	147.24	141.30 – 153.18	159.71	153.77 – 165.65	**0.005**	0.65
Trabecular vBMD (mg/cm³)	161.81	152.21 – 174.41	175.32	165.72 – 184.92	0.055	0.44
Cortical vBMD (mg/cm³)	794.11	774.69 – 813.53	823.84	804.42 – 843.26	**0.037**	0.47
Integral vBMD (mg/cm³)	291.41	276.94 – 305.87	315.77	301.30 – 330.23	**0.022**	0.52
Cortical thickness (mm)	1.85	1.81 – 1.90	1.93	1.89 – 1.97	**0.011**	0.63

PHPT have lower aBMD at the hip sites and reduced cortical 3D parameters compared with an age- and sex-matched healthy control group. In addition, the vBMD of the trabecular compartment seems to be affected, although to a lesser extent.

COUNTRY & AUTHORS:

Spain

Gracia-Marco, L.
García-Fontana, B.
Ubago-Guisado, E.
Vlachopoulos, D.
García-Martín, A.
Muñoz-Torres, M.

STUDY: Primary Hyperparathyroidism (PHPT) impaired 3D cortical density at femur as assessed from 2D DXA

[2017]

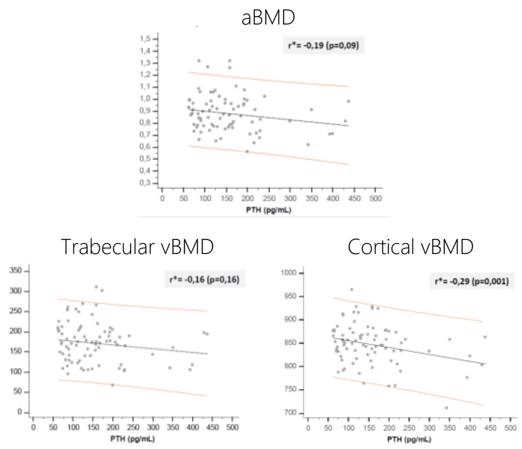
Abstract not currently Available

COHORT: 81 adults (59.4 ± 13.5 yrs) with PHPT.

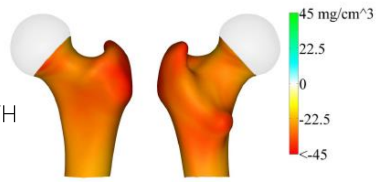
OUTCOMES: Negative effect of PTH level on the Cortical vBMD and mean Cortical Thickness.

No effects were observed in the Trabecular compartment.

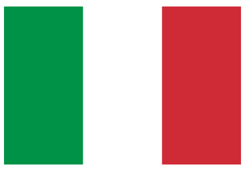
RESULTS & VISUALIZATIONS:



Differences in cortical vBMD between subjects from PTH level 1st quatile and 4th quartile



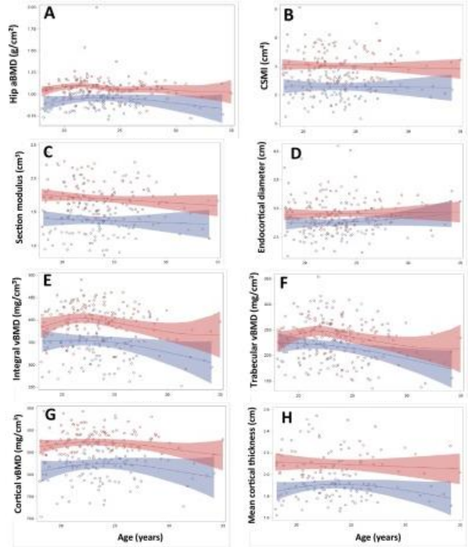
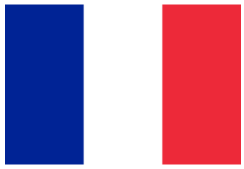
COUNTRY & AUTHORS:



Italy

Guglielmi, G.
Winzenrieth, R.
Battista, C.
Scillitani, A.

Obesity

STUDY	COHORT	OUTCOMES	RESULTS & VISUALIZATIONS	COUNTRY & AUTHORS
Modification of bone mineral density, bone geometry and volumetric BMD in young women with obesity. [2021] Available here	220 adolescent and young women from 18 to 35 years old • 128 patients with obesity • 92 age-matched (±6 months) normal-weight controls	Young women with obesity presented higher aBMD, better hip geometry and greater strength compared with normal-weight controls. Cortical and trabecular compartments measured by 3D-SHAPER® were favourably and concomitantly modified.	 Subjects with obesity presented significantly higher aBMD at all bone sites. Bone size & strength estimates were higher at all femoral subregions in young women with obesity. vBMD was higher in subjects with obesity, but the difference between groups was greater for cortical vBMD compared with trabecular vBMD	 France Maïmoun L, Renard E, Humbert L, Aouinti S, Mura T, Boudousq V, Lefebvre P, Mahadea K, Philibert P, de Santa-Barbara P, Avignon A, Guillaume S, Sultan A, Nocca D, Mariano-Goulart D.

Diabetes

STUDY	COHORT	OUTCOMES	RESULTS & VISUALIZATIONS	COUNTRY & AUTHORS
Relationship Between Insulin Resistance (HOMA-IR), Trabecular Bone Score (TBS), and Three-Dimensional Dual-Energy X-ray Absorptiometry (3D-DXA) in Non-Diabetic Postmenopausal Women. [2020] Available here	381 postmenopausal women	In non-diabetic postmenopausal women there was a direct relationship between insulin resistance and vBMD, whose effect is directly related to greater weight. This might be explained by the formation of advanced glycosylation products (AGEs) in the bone matrix, which reduces bone deformation capacity and resistance, as well as increases fragility.	Women located in quartile 4 (Q4) of HOMA-IR had higher values of volumetric bone mineral density (vBMD) but not TBS. The increase was higher in the trabecular compartment (16.4%) than in the cortical compartment (6.4%). Similar results were obtained for insulin.	 Spain Campillo-Sánchez F, Usategui-Martín R, Ruiz-de Temiño A, Gil J, Ruiz-Mambrilla M, Fernández-Gómez JM, Dueñas-Laita A, Pérez-Castrillón JL.

Cancer

STUDY

The effect of an online exercise programme on bone health in paediatric cancer survivors (iBoneFIT): study protocol of a multi-centre randomized controlled trial.

[2020]

Available here

COHORT

116 Subjects

- Aged 6 to 18
- Intervention (n=58)
- Control (n=58)

OUTCOMES

This article describes the design, rationale and methods of a study intended to test the effect of a rigorous online exercise programme on bone health in paediatric cancer survivors. If successful, the iBoneFIT study will contribute to decrease chronic health conditions in this population and will have a positive impact in the society.

RESULTS & VISUALIZATIONS

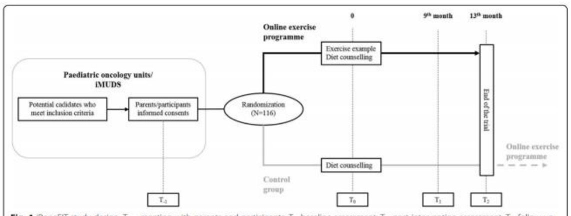


Fig. 1 iBoneFIT study design. T_{-1}, meeting with parents and participants; T_0, baseline assessment; T_1, post-intervention assessment; T_2, follow-up assessment. iMUDS *Sport and Health University Research Institute*

Table 3 iBoneFIT study exercise programme periodisation

Phase	Warm up[a]	Exercise[b]	Level	Repetitions	Sets a day (Rest[c])	Sessions a Week	Squats/Jumps a Week
1	RAMP	BM-based Squat	1 (1–4 wk)	15	3	4	180
			2 (5–8 wk)	20	4	4	320
Total phase 1 (8 wk)							2000
2	RAMP	SJ	1 (9–12 wk)	10	3	3	90
			2 (13–16 wk)	15	3	4	180
			3 (17–20 wk)	20	4	4	320
Total phase 2 (12 wk)							2360
3	RAMP	CMJ	1 (21–24 wk)	10	3	3	90
			2 (25–28 wk)	12	3	4	144
			3 (29–32 wk)	15	3	4	180
			4 (33–36 wk)	20	4	4	320
Total phase 3 (16 wk)							2936
Total intervention (36 wk)							7296

RAMP raise, activate, mobilise and potentiate, *BM* body mass, *SJ* squat jump, *CMJ* countermovement jump
[a]Warm up will be focused on dynamic exercises with progressive intensity enhancing optimal core body temperature, motor unit excitability, kinesthetic awareness and ranges of motion
[b]Each exercise will be suggested to be performed at the pace of the personal trainer managing the session. If not, a self-paced performance will be recommend
[c]Phase 1 rest = 45 s
Phases 2 and 3 rest = 1 min

COUNTRY & AUTHORS

Spain

Gil-Cosano JJ, Ubago-Guisado E, Sánchez MJ, Ortega-Acosta MJ, Mateos ME, Benito-Bernal AI, Llorente-Cantarero FJ, Ortega FB, Ruiz JR, Labayen I, Martinez-Vizcaino V, Vlachopoulos D, Arroyo-Morales M, Muñoz-Torres M, Pascual-Gázquez JF, Vicho-González MC, Gracia-Marco L.

Glucocorticoids

STUDY

Daily low dose of glucocorticoids induces trabecular and cortical bones impairment at the femur: a 3D analysis using DXA-based modelling.

[2018]

Available here

COHORT

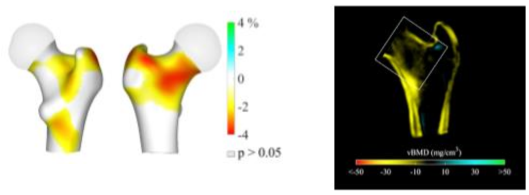
402 patients (females and males) treated with low dose of GC (>5mg/d for >3 months); Versus 1,087 gender-, age- and BMI-matched controls

OUTCOMES

An impairment of both cortical and trabecular bone is observed in patients treated with GC, even with low dose, with:

- Effect on the cortical bone at the total femur
- Effect on the trabecular bone localized at the femoral neck

RESULTS & VISUALIZATIONS



- On 2D: significantly lower aBMD at total femur in GC (while no significant difference at lumbar spine)
- On 3D: significantly lower cortical surface BMD at total femur & lower trabecular volumetric BMD localized at the femoral neck

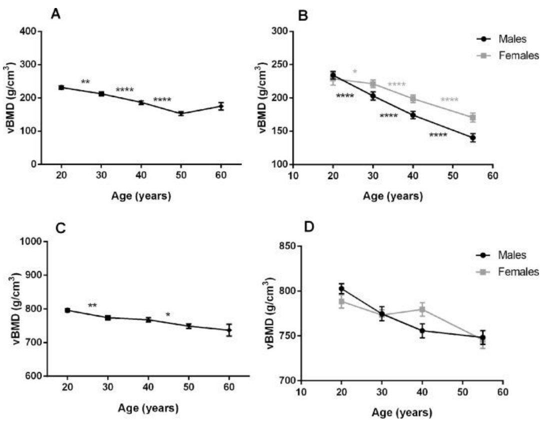
In a sub-analysis of fractured subjects, lower cortical sBMD and trabecular vBMD observed at the total femur, and significantly lower in GC-treated Fx vs GC-treated without fx.

COUNTRY & AUTHORS

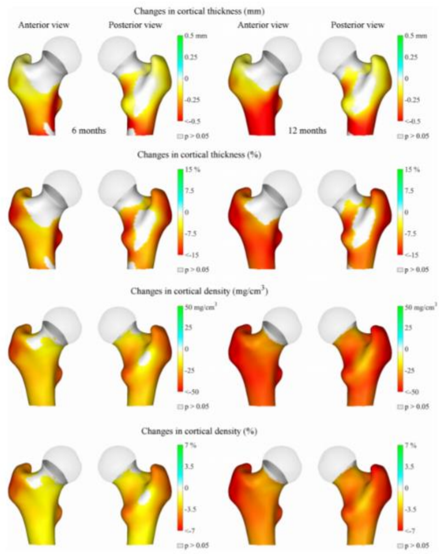
USA

Manasanch Berengué A, Winzenrieth R, Humbert L, Leib E.

Down Syndrome

STUDY	COHORT	OUTCOMES	RESULTS & VISUALIZATIONS	COUNTRY & AUTHORS
Volumetric BMD by 3D-DXA and Trabecular Bone Score in Adults With Down Syndrome. [2021] Available here	297 Adult subjects with Down Sydrome. Males & Females	Trabecular vBMD at total hip and femoral neck was lower in males than in females. Trabecular and cortical vBMD decreased with age, but age decline in trabecular vBMD was more pronounced in males. Both 3D-DXA & TBS could be used as complementary tools to areal BMD		 Spain Costa R, Real de Asúa D, Gullón A, De Miguel R, Bautista A, García Emilia Roy C, García-Vadillo J, Suárez C, Moldenhauer F, Castañeda S.

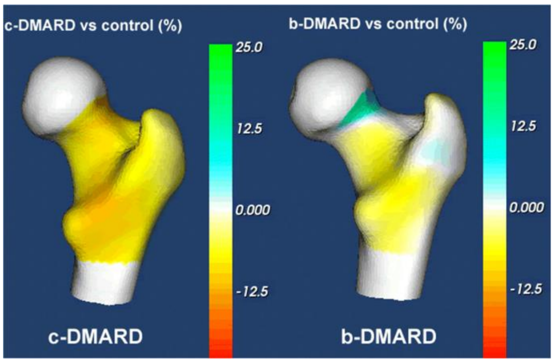
Spinal Cord Injury

STUDY	COHORT	OUTCOMES	RESULTS & VISUALIZATIONS	COUNTRY & AUTHORS
Analysis of the evolution of cortical and trabecular bone compartments in the proximal femur after spinal cord injury by 3D-DXA. [2018] Available here	16 Subjects • Male • SCI <3 months since injury • Without anti-osteoporotic treatment	Marked trabecular and cortical bone loss was observed at the proximal femur short-term after SCI. 3D-DXA measured vBMD evolution at both femoral compartments and cortical thinning, providing better knowledge of their differential contributory role to bone strength and probably of the effect of therapy in these patients.	 vBMD significantly decreased at integral, trabecular, and cortical compartments at 6 months, with a further decrease at 12 months. Resulting in an overall decrease of - 16.6, - 21.9, and - 5.0%, respectively. Cortical thickness also decreased at 6 and 12 with the maximal decrease being observed during the first 6 months.	 Spain Gifre L, Humbert L, Muxi A, del Rio L, Vidal J, Portell E, Monegal A, Guañabens N, Peris P.

Rheumatoid Arthritis

<table>
<tr><th>STUDY</th><th>COHORT</th><th>OUTCOMES</th><th>RESULTS & VISUALIZATIONS</th><th>COUNTRY & AUTHORS</th></tr>
<tr>
<td>Trabecular and cortical bone involvement in rheumatoid arthritis by DXA and DXA-based 3D modelling.

[2020]

Available here</td>
<td>205 Adults
• 105 RA patients
• 100 controls group</td>
<td>3D-DXA allowed us to find changes in trabecular and cortical bone compartments in RA patients otherwise not apparent using standard DXA</td>
<td>

c-
DMARD (n = 75) group showed significantly lower trabecular and cortical vBMD than the CG.

Despite the lower values, the b-DMARD group (n = 30) showed no significant differences in most parameters compared with the CG.

The trabecular and cortical 3D parameters were significantly lower in the group with an RA disease duration of 1 to 5 years than in the CG, and the trabecular vBMD was significantly lower in the group with a duration of corticosteroid therapy of 1 to 5 years than in the CG.</td>
<td>
Argentina

Brance ML,
Pons-Estel BA,
Quagliato NJ,
Jorfen M,
Berbotto G,
Cortese N,
Raggio JC,
Palatnik M,
Chavero I,
Soldano J,
Dieguez C,
Sánchez A,
Del Rio L,
Di Gregorio S,
Brun LR.</td>
</tr>
</table>

Hypophosphatasia

<table>
<tr><th>STUDY</th><th>COHORT</th><th>OUTCOMES</th><th>RESULTS & VISUALIZATIONS</th><th>COUNTRY & AUTHORS</th></tr>
<tr>
<td>Evaluation of bone mineral density and 3D-Shaper parameters in congenital hypophosphata-sia of the adult.

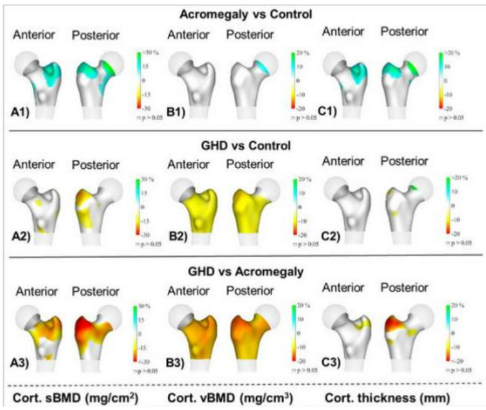
[2021]

Available here</td>
<td>33 Adults with HPP with heterozygous mutation
• 21 women
• 12 men</td>
<td>No differences in BMD between subjects with and without stress fractures

3D-Shaper showed a decrease in cortical thickness between patients with stress fractures vs without them and those with traumatic fractures</td>
<td><table>
<tr><th>Characteristics</th><th>TG+ (N=33)</th></tr>
<tr><td>Age (years), median (IQR)
Age (years), mean ± SD</td><td>51.01 (37.96-63.02)
50.56 ± 15.08</td></tr>
<tr><td>Female gender, n (%)</td><td>21 (63.6%)</td></tr>
<tr><td>Postmenopausal women, n (%)</td><td>9 (42.9%)</td></tr>
<tr><td>Men >50 years, n (%)</td><td>8 (66.6%)</td></tr>
<tr><td>BMI (kg/m²), median (IQR)
BMI (kg/m²), mean ± SD</td><td>25.91 (22.89-29.25)
26.31 ± 4.39</td></tr>
<tr><td>Caucasian race, n (%)</td><td>33 (100%)</td></tr>
<tr><td>Calcium intake (g), median (IQR)
Calcium intake (g), mean ± SD</td><td>400 (250-500)
401.52 ± 152.32</td></tr>
<tr><td>Smoking habit, n (%)</td><td>6 (18.2%)</td></tr>
<tr><td>Alcohol intake ≥30 g, n (%)</td><td>0%</td></tr>
<tr><td>Regular exercise, n (%)</td><td>19 (57.6%)</td></tr>
<tr><td>Solar exposure, n (%)</td><td>19 (57.6%)</td></tr>
<tr><td>Family history of hip fracture, n (%)</td><td>4 (12.1%)</td></tr>
<tr><td>PH traumatic fracture, n (%)</td><td>10 (30.3%)</td></tr>
<tr><td>PH fragility fracture, n (%)</td><td>0 (0%)</td></tr>
<tr><td>PH stress fractures, n (%)</td><td>5 (15.2%)</td></tr>
<tr><td>APH (IU/L), median (IQR)
APH (IU/L), mean ± SD
(RN: 46-116 IU/L)</td><td>25 (20.5-27.5)
25.2 ± 6.53</td></tr>
<tr><td>PTH (pg/ml), median (IQR)
PTH (pg/ml), mean ± SD
RN: 18.5-88 pg/ml</td><td>37 (30.5-64)
44.82 ± 22.41</td></tr>
<tr><td>Vit. D (ng/ml), median (IQR)
Vit. D (ng/ml), mean ± SD
(RN: 30-100 ng/ml)</td><td>19 (13-23.5)
20 ± 9.75</td></tr>
</table>
Decrease in cortical thickness (mm) in patients with stress fractures [1.8 (1.77-1.89)] compared to subjects without them [1.94 (1.87-2.03, p=0.03)] and compared to those with traumatic fractures [1.97 (1.88-2.04), p=0.03].</td>
<td>
Spain

Tornero C,
Coronado M,
Humbert L,
Navarro-Compán V,
García Carazo S,
Lancha Hernández C,
Balsa A,
Aguado Acín P.</td>
</tr>
</table>

Acromegaly

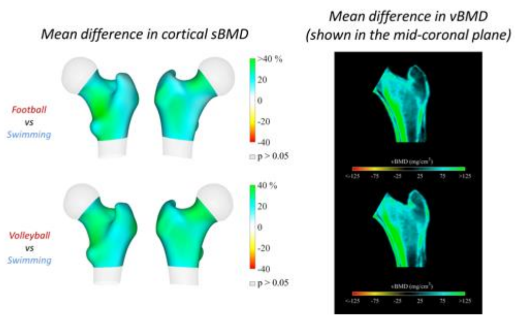
STUDY	COHORT	OUTCOMES	RESULTS & VISUALIZATIONS	COUNTRY & AUTHORS
3D DXA Hip Differences in Patients with Acromegaly or Adult Growth Hormone Deficiency. [2021] Available here	67 Subjects • 20 Acromegaly • 14 AGHD • 33 Controls	3D-DXA provided useful information about the characteristics of bone involvement in growth hormone (GH)-related disorders. Patients with AGHD showed distinct involvement of the cortical structure.	 The mean-adjusted 3D-DXA parameters did not differ between acromegaly patients and the controls ($p > 0.05$) Cortical bone impairment (−7.3% to −8.4%; effect size (ES) = 0.78) in AGHD patients ($p < 0.05$). Differences in the cortical bone parameters were more evident when comparing AGHD patients (−8.5% to −16.2%; ES = 1.22 to 1.24) with acromegaly patients ($p < 0.05$).	 Spain Gracia-Marco L, Gonzalez-Salvatierra S, Garcia-Martin A, Ubago-Guisado E, Garcia-Fontana B, Juan Gil-Cosano J, Muñoz-Torres M.
Vertebral Fractures Occur Despite Control of Acromegaly and Are Predicted by Cortical Volumetric Bone Mineral Density. [2021] Available here	70 Acromegaly Subjects • 26 Active Acromegaly	The most sensitive and specific predictor of incident VF was TH cortical vBMD, suggesting that cortical bone is involved in fracture development.	In 13 patients, 9 with controlled disease, VF was observed. A decrease in TBS, sBMD, neck trabecular vBMD, TH, and neck cortical vBMD in VF compared with non-VF subjects was observed ($P < .05$). Multivariate analysis of fracture prediction showed TH cortical vBMD as the best fracture prediction parameter with area under the curve of 0.774. TBS was negatively associated with fasting plasma glucose and glycated hemoglobin (HBA1c) at each time point during the follow-up.	 Slovakia Kužma M, Vaňuga P, Ságová I, Pávai D, Jackuliak P, Killinger Z, Binkley NC, Winzenrieth R, Genant HK, Payer J.

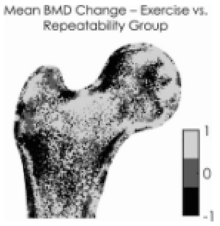
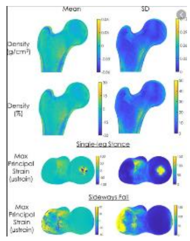
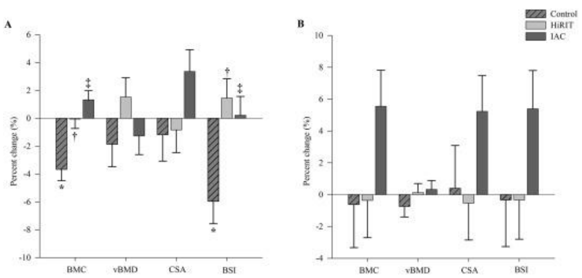
Sport, exercise, muscle & bone

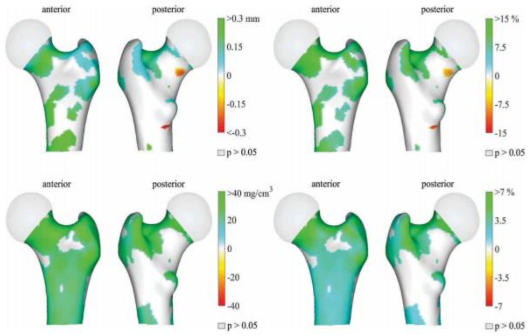
There's a lot of interest in the field on how non-pharmacological therapies can impact bone health and density and reduce a patient's chance of fracture. Using 3D-Shaper, clinicians and researchers have been able to fully explore the specific effects that lifestyle changes are having on the bone at a local level (cortical, trabecular and integral bone compartments).
Understanding the Physiological effects of a healthy lifestyle carries great significance, and 3D-Shaper's technology enables users to ***better understand their patients***, thus identifying the best way to manage and treat them.

Below are examples of how 3D-Shaper has been used to generate insights into the effect of sport & exercise on bone health and density:

To date, there has been a total of 18 studies across 5 countries:

KEY PUBLICATION				
STUDY	COHORT	OUTCOMES	RESULTS & VISUALIZATIONS	COUNTRY & AUTHORS
Femur 3D-DXA assessment in female football players, swimmers and sedentary controls. [2022] Available here	Elite female athletes (from FC Barcelona & Spanish national swimming teams);	3D-DXA modelling could provide insight into bone remodelling in sports field, allowing to evaluate femoral trabecular and cortical strength from standard DXA scans.	 Football (Soccer) players showed 20% higher cortical sBMD and 17% higher trabecular vBMD. 3D-DXA modelling revealed **statistical differences in cortical thickness and vBMD** between athletes engaged in weight-bearing (football) and non-weight bearing (swimming) sports. No differences between the non-weight bearing sport and the sedentary controls.	 Spain Amani A, Bellver M, Del Rio L, Ramon Torrella, J Lizarraga A, Humbert L, Drobnic F.

STUDY	COHORT	OUTCOMES	RESULTS & VISUALIZATIONS	COUNTRY & AUTHORS
Assessment of femoral neck strength and bone mineral density changes following exercise using 3D-DXA images. [2021] Available here	10 females and 26 males	3D-DXA technology can assess the effect of exercise interventions in large cohorts	  In the repeated images, the total hip vBMD difference was 0.5 ± 2.5%. Element-by-element BMD differences reached 30 ± 50%. The exercise group had a mean bone accrual exceeding repeatability values in the femoral head and cortical regions. The case with the highest vBMD change (6.4%) caused 18% and −7% strength changes under single-leg stance and sideways fall.	 Australia O'Rourke D, Beck B, Harding A, Watson S, Pivonka P, Martelli S.
Effects of Supervised High-Intensity Resistance and Impact Training or Machine-Based Isometric Training on Regional Bone Geometry and Strength in Middle-Aged and Older Men With Low Bone Mass: The LIFTMOR-M Semi-Randomised Controlled Trial. [2020] Available here	93 Men with lower than average aBMD	Findings indicate that supervised HiRIT provides a positive stimulus to cortical bone at the medial FN compared with supervised IAC exercise Both HiRIT and IAC preserve bone strength at the distal tibia and distal radius. Effects may translate into a reduced risk of lower and upper extremity fracture in middle-aged and older men with low bone mass.	 HiRIT improved medial FN cortical thickness compared with CON (5.6 ± 1.7% versus −0.1 ± 1.9%, p = 0.028) and IAC (5.6 ± 1.7% versus 0.7 ± 1.7%, p = 0.044). Distal tibia total BMC, vBMD, area and bone strength index, and trabecular BMC and bone strength index all declined for CON compared with maintenance for both HiRIT and IAC (all p < 0.05). HiRIT maintained distal tibia trabecular area compared with a loss in CON (0.2 ± 0.5% versus −1.6 ± 0.5%, p = 0.013)	 Australia Harding A, Weeks B, Lambert C, Watson S, Weis L, Beck B.

STUDY	COHORT	OUTCOMES	RESULTS & VISUALIZATIONS	COUNTRY & AUTHORS
Cortical and trabecular bone analysis of professional dancers using 3D-DXA: a case-control study. [2018] Available here	80 Subjects • 40 Professional dancers • 40 Controls	Elite ballet dancing does not appear to have a deleterious effect on bone health. Professional ballet dancers have higher BMD for both cortical and trabecular bone compartments.	 Compared to non-exercising participants, dancers exhibited significantly higher volumetric density for integral, cortical and trabecular bone, and thicker cortex at the femur.	 Portugal Freitas L, Amorim T, Humbert L, Fonollá R, Flouris AD, Metsios GS, Jamurtas AZ, Koutedakis Y.

Full Study Bibliography

Technical & Validation

1. Martin, D. *et* al. Clinical Physician Assessment during total hip arthroplasty correlates with DXA parameters. ISCD Annual Meeting 2023.
2. López Picazo, M., Humbert, L., Winzenrieth, R., Black, D. Accuracy of Femoral Shape, Trabecular and Cortical bone measurements using DXA-based 3D modelling in subjects from the US. ASBMR 2022 Annual Meeting.
3. Qasim, M. *et al.* 3D-Shaper Based Finite Element Analyses as an Alternative to QCT Based Analyses for Femur Strength Estimation. ASBMR 2022 Annual Meeting.
4. Kai, K. *et al.* Assessment of proximal femoral bone structure by DXA: Recent advances and clinical applications. Japanese Society for Bone Morphometry Annual Meeting 2022.
5. Suzuki, Y. *et al.* Comparison of bone structure with different YAM values of the proximal femur using 3D-Shaper. Japanese Society for Bone Morphometry Annual Meeting 2022.
6. Suzuki, Y. *et al.* Verification of possible errors in automated 3D-SHAPER analysis. Japanese Society for Bone Morphometry Annual Meeting 2022.
7. Di Gregorio, S., Brance, L., Romero Martinez, S., Solé Massana, C., Del Rio, L., Lopez Medina, M. Is the evaluation of 3D-DXA parameters useful in clinical practice? WCO-IOF-ESCEO 2022.
8. Di Gregorio, S., Brance, L., Lopez Medina, M., Romero Martinez, S., Brun, L., Del Rio, L. Which are the factors that influence at hip bone 3D-DXA volumetric parameters. WCO-IOF-ESCEO 2022.
9. T. Sone, L. Humbert, M. Lopez, R. Winzenrieth, K. Ohnaru. Assessment of femoral shape, trabecular and cortical bone in Japanese subjects using DXA-Based 3D modelling. ASBMR 2021 Annual Meeting.
10. E Spector, G Yardley, D Krueger, H Goel, N Binkley, J Sibonga. Validation of a Modified DXA Software to Identify Astronauts at Risk for Persistent Spaceflight-induced Bone Loss. ISCD 2021.
11. Yusuke Suzuki, Motokazu Kai, Ikuko Tanaka, et.al. Hip Structural Analysis (HSA) using DXA and 3D-SHAPER. JOS & JSBMR 2021.
12. Del Rio Barquero L., et al. Cambios locales de densidades volumétricas cortical y trabecular con la edad en población española, utilizando modelos 3D de fémur proxmial basados en dxa: proyecto seiomm - 3D-Shaper. SEIOMM 2021.
13. Di Gregorio S., Brance M. L., Lopez Medina M. , Romero Martínez S., Solé C. Brun L. Parámetros 3d de cadera. Utilidad clínica en la interpretación de respuestas terapéuticas al tratamiento para osteoporosis. SEIOMM 2021.
14. DI Gregorio S., Ortiz S., Del Rio Barquero L. Evaluación de potenciales factores determinantesde los componentes de cadera volumétricos (3D-DXA). Estudio poblacional. SEIOMM 2021.
15. Antonia García Martín, *et al.* New technologies in the evaluation of bone fragility and their application in endocrinology. Endocrinol Diabetes Nutr (Engl Ed). 2020 Nov;67(9):602-610. DOI : 10.1016/j.endinu.2020.01.005.
16. Del Rio LM, Di Gregorio S, Brance L, Brun L. 3D-DXA parameters in lumbar spine: changes throughout life in female population - preliminary results. WCO-IOF-ESCEO 2020.
17. Brance M, *et al.* References values of three-dimensional proximal femur parameters from bone densitometry images in healthy subjects from Argentina. WCO-IOF-ESCEO 2020.
18. López Picazo M, Bejarano López L, Humbert L, Cons Molina F. Anatomical distribution of the differences in DXA-derived vBMD at the lumbar spine between subjects with L1 vertebra fracture and controls. WCO-IOF-ESCEO 2020.
19. Di Gregorio S, *et al.* Are vertebral 3D-DXA parameters useful to discriminate vertebral fractures? WCO-IOF-ESCEO 2020.

20. Mann A, *et al.* Hip areal BMD by DXA (aBMD) and hip volumetric BMD by 3D modeling of hip DXA (vBMD) are highly correlated in both fracture prevalent and fracture non-prevalent osteoporosis patients. WCO-IOF-ESCEO 2020.
21. Ruiz Wills C, *et al.* 3D patient-specific finite element models of the proximal femur based on DXA towards the classification of fracture and non-fracture cases. Bone. 2019 Apr;121:89-99. DOI : 10.1016/j.bone.2019.01.001.
22. Humbert L, *et al.* 3D Analysis of Cortical and Trabecular Bone From Hip DXA: Precision and Trend Assessment Interval in Postmenopausal Women. J Clin Densitom. 2019 Apr - Jun;22(2):214-218. DOI : 10.1016/j.jocd.2018.05.001.
23. Casado Burgos E, *et al.* Datos de referencia de mediciones óseas en modelos 3d de fémur proximal en población español con DXA: PROYECTO SEIOMM - 3D-SHAPER. SEIOMM 2019.
24. Gerganova A, *et al.* Comparison between 3D-SHAPER® analysis and standard 2D DXA scan of the proximal femur. WCO-IOF-ESCEO 2019.
25. Clotet J, *et al.* Structural Parameters of the Proximal Femur by 3-Dimensional Dual-Energy X-ray Absorptiometry Software: Comparison With Quantitative Computed Tomography. J Clin Densitom. 2018 Oct - Dec;21(4):550-562. DOI : 10.1016/j.jocd.2017.05.002.
26. Di Gregorio *et al.* Evaluación de los componentes cadera mediante parámetros 3D y sus potenciales factores determinantes. AAOMM-SAO 2018.
27. Humbert l, Di Gregorio S. Simposio: Utilidad de la reconstrucción 3D de cadera: de la investigación a la aplicación clínica. AAOMM-SAO 2018.
28. Humbert L, Del Río Barquero LM, Malouf J, Winzenrieth R. Sponsored SEIOMM Symposium: 3D-SHAPER: Analyzing the Proximal Femur in 3D from Hip DXA Scan. ECTS 2018.
29. Ruiz Wills C, *et al.* Major Principal Stress (MPS) derived through DXA-based 3D modelling as a high predictive new variable for hip fracture. WCO-IOF-ESCEO 2018.
30. Humbert L, *et al.* 3D-DXA: Assessing the Femoral Shape, the Trabecular Macrostructure and the Cortex in 3D from DXA images. IEEE Trans Med Imaging. 2017 Jan;36(1):27-39. DOI : 10.1109/TMI.2016.2593346.
31. Humbert L, *et al.* Precision assessment of cortical thickness and volumetric bone mineral density measured by 3D-DXA. SEIOMM 2017.
32. Humbert L, *et al.* Precision assessment of cortical thickness and volumetric bone mineral density derived from hip DXA scans using 3D DXA. ASBMR 2017 Annual Meeting.
33. Humbert L, Di Gregorio S, Del Río Barquero LM. Short-term precision assessment and monitoring time interval to assess bone status in postmenopausal women by 3D-DXA. WCO-IOF-ESCEO 2017.
34. Humbert L, *et al.* Technical Note: Cortical thickness and density estimation from clinical CT using a prior thickness-density relationship. Medical Physics 2016 Apr;43(4):1945. DOI : 10.1118/1.4944501.
35. López Picazo M, *et al.* 3D-Shaper Spine: Modelling the lumbar Spine in 3D from DXA images. ASBMR 2016 Annual Meeting.
36. Magallón Baro A, *et al.* Medidas sobre la geometría y la densidad mineral ósea de la columna lumbar obtenidas mediante la tecnología 3D-DXA. SEIOMM 2016.
37. Fonollà R, *et al.* Datos de referencia para medidas del hueso cortical y trabecular mediante la tecnología 3D-DXA. SEIOMM 2016.
38. Humbert L, *et al.* Structural parameters computed by 3D-DXA: accuracy evaluation against quantitative computed tomography. WCO-IOF-ESCEO 2016.
39. Camargos BM, Silva BC, Humbert L, Del Río Barquero LM. Clinical Applicability of 3D-DXA in Individuals with Small Bone Size and Low Bone Mineral Density: a Case Report. WCO-IOF-ESCEO 2016.
40. Fonollà R, *et al.* 3D-DXA Validation using Hologic DXA images. WCO-IOF-ESCEO 2015.
41. Del Río Barquero LM. Densitometría ósea volumétrica: ¿Es el futuro? SEIOMM 2015.
42. Humbert L, Whitmarsh T, del Río Barquero LM, Frangi AF. Computing structural parameters from Dual-energy X-ray Absorptiometry using a 3D reconstruction method. WCO-IOF-ESCEO 2015.
43. Humbert L, Martelli Y, Di Gregorio S, del Río Barquero LM. 3D-DXA: a 3D Modelling Method of the Proximal Femur Integrated in DMS DXA Device. WCO-IOF-ESCEO 2014.

44. Whitmarsh T, *et al.* 3D Reconstruction of the Lumbar Vertebrae from Anteroposterior and Lateral Dual-energy X-ray Absorptiometry. Medical Image Analysis, 2013 May;17(4):475-87. DOI : 10.1016/j.media.2013.02.002.
45. Humbert L, *et al.* Comparison between Single and Multi-view Simulated DXA Configurations for Reconstructing the 3D Shape and Bone Mineral Density Distribution of the Proximal Femur. Medical Physics, 2012 Aug;39(8):5272-6. DOI : 10.1118/1.4736540.
46. Humbert L, *et al.* Femoral Strength Prediction using a 3D Reconstruction Method from Dual-Energy X-rays Absorptiometry. IEEE International Symposium on Biomedical Imaging 2012, 1451-1454. DOI : 10.1109/ISBI.2012.6235844.
47. Humbert L, *et al.* Femoral Strength Prediction using a 3D Reconstruction Method from Dual-Energy X-ray Absorptiometry. ISBI 2012.
48. Martelli Y, *et al.* A software framework for 3D reconstruction and fracture risk assessment of the proximal femur from dual-energy x-ray absorptiometry. VPH conference 2012.
49. Spinelli M, *et al.* FE prediction of strains for patient-specific proximal femurS generated from a single DXA. ESB 2012.
50. Del Río Barquero LM, *et al.* Densitometria ósea en 3D. Nuevos avances en estimación del riesgo de fractura. Densitometría ósea en ortopedia. V Curso de densitometría clínica de SOVEMO 2012.
51. Humbert L, *et al.* 3D Reconstruction of Bony Structures from DXA Images. III Jornades R+D+I en TIC I Salut 2012.
52. Whitmarsh T, *et al.* Reconstructing the 3D Shape and Bone Mineral Density Distribution of the Proximal Femur from Dual-energy X-ray Absorptiometry. IEEE Transactions on Medical Imaging, 2011 Dec;30(12):2101-14. DOI : 10.1109/TMI.2011.2163074.
53. Whitmarsh T, Humbert L, Del Río Barquero LM, Frangi AF. Volumetric Bone Mineral Density Estimation using a 3D Reconstruction Method from Dual-energy X-ray Absorptiometry. ASBMR 2011 Annual Meet
54. Humbert L, *et al.* 3D reconstruction of both shape and bone mineral density distribution of the femur from dxa images. ISBI 2010.
55. Whitmarsh T, *et al.* 3D Bone Mineral Density Distribution and Shape Reconstruction of the Proximal Femur from a Single DXA Image. SPIE 2010

Association with Fracture

56. M. Iki, *et al.* Predictive ability of novel volumetric and geometric indices derived from dual-energy X-ray absorptiometric images of the proximal femur for hip fracture compared with conventional areal bone mineral density: the Japanese Population-based Osteoporosis (JPOS) Cohort Study. Osteoporos Int. 2021 May 26. DOI :10.1007/s00198-020-05806-1.
57. M. Iki, *et al.* Performance of Fracture Prediction with a Novel Bone Index based on 3D Modeling of the DXA hip images - JPOS Cohort Study. JOS & JSBMR 2021.
58. López Picazo M, *et al.* Association between osteoporotic femoral neck fractures and DXA-derived 3D measurements at lumbar spine: a case-control study. Arch Osteoporos. 2020 Jan 3;15(1):8. DOI : 10.1007/s11657-019-0680-4.
59. López Picazo M, *et al.* Discrimination of osteoporosis-related vertebral fractures by DXA-derived 3D measurements: a retrospective case-control study. Osteoporos Int. 2019 May;30(5):1099-1110. DOI : 10.1007/s00198-019-04894-y.
60. Montoya MJ, *et al.* Mediciones óseas en modelos 3D de fémur proximal con DXA, en pacientes con fracturas por fragilidad. SEIOMM 2019.
61. Di Gregorio S, *et al.* Análisis tipos de fractura fémur proximal mediante mediciones óseas DXA-3D. SEIOMM 2019.
62. Del Río Barquero LM, *et al.* Local bone density defects in patients with femoral neck fracture. SEIOMM 2019.
63. López Picazo M, *et al.* Association between osteoporosis-related vertebral fractures and DXA-derived 3D measurements at lumbar spine. ASBMR2019 Annual Meeting.
64. Di Gregorio S, Brance L, Humbert L, Del Río Barquero LM. 3D-DXA measurements in lumbar spine in patients with vertebral fractures. ASBMR2019 Annual Meeting.
65. Biver E, *et al.* DXA-based 3D mapping of hip cortical thinning correlates with incident fractures in postmenopausal women from the GERICO cohort. ASBMR2019 Annual Meeting.
66. Di Gregorio S, *et al.* 3D analysis of local bone density defects in patients with femoral neck fracture. WCO-IOF-ESCEO 2019.
67. Gerganova A, *et al.* 3D-SHAPER® Analysis of volumetric BMD at proximal femur during menopausal transition. WCO-IOF-ESCEO 2019.
68. Di Gregorio S, *et al.* Analysis of bone structural parameters by DXA-3D in cervical and trochanteric hip fractures. WCO-IOF-ESCEO 2019.
69. Biver E, *et al.* DXA-based 3D analysis of proximal femur cortical and trabecular bone for fracture risk assessment: a prospective study in postmenopausal women. WCO-IOF-ESCEO 2019.
70. Humbert L, *et al.* DXA-Based 3D Analysis of the Cortical and Trabecular Bone of Hip Fracture Postmenopausal Women: A Case-Control Study. J Clin Densitom. 2018 Nov 13. DOI : 10.1016/j.jocd.2018.11.004.
71. López Picazo M, *et al.* 3D Subject-Specific Shape and Density Estimation of the Lumbar Spine from a Single Anteroposterior DXA Image Including Assessment of Cortical and Trabecular Bone. IEEE Transactions on Medical Imaging, 2018 Dec; 37(12):2651-2662. DOI : 10.1109/TMI.2018.2845909.
72. López Picazo M, *et al.* Can DXA-derived 3D measurements at the lumbar spine predict thoracic spine fractures? SEIOMM 2018.
73. Di Gregorio *et al.* Factores estructurales óseos en fémur y masa magra evaluados por 3D-DXA en pacientes con fractura de cadera. Datos preliminares. AAOMM-SAO 2018.
74. López Picazo M, *et al.* Can DXA-derived 3D measurements at the lumbar spine predict thoracic spine fractures? ASBMR 2018 Annual Meeting.
75. Winzenrieth R, Humbert L, Leib E. Cortical and trabecular bone of patients with prevalent major osteoporotic fracture: a case-control study using DXA-based 3D modelling. ASBMR 2018 Annual Meeting.
76. Guardiola S, *et al.* Supervised Machine Learning Techniques for Hip Fracture Prediction from DXA-based 3D Patient-Specific Femur Model Fall Simulations. ASBMR 2018 Annual Meeting.

77. Del Río Barquero LM, Di Gregorio S, Sanchez P. Bone structural components and lean mass assessed by 3D-DXA in Hip Fracture Patients. ECTS 2018.
78. Ruiz Wills C, *et al.* Pedicting the risk of hip fracture from DXA-based 3D finite element simulations. ECTS 2018.
79. Galich AM, *et al.* Analyzing the cortical and trabecular bone of the femur of patients with vertebral fractures using DXA-based 3D modelling. WCO-IOF-ESCEO 2018.
80. Galich AM, *et al.* Análisis por 3D-DXA del hueso cortical y trabecular del fémur en pacientes con fracturas previas. XX Congreso SAEM 2017.
81. Galich AM, *et al.* Análisis por 3D-DXA del hueso cortical y trabecular del fémur en pacientes con fracturas previas. AAOMM 2017.
82. Del Río Barquero LM, *et al.* 3D-DXA. Aplicación del análisis de elementos finitos en sujetos con fractura de cadera. SEIOMM 2017.
83. Galich AM, *et al.* Analyzing the cortical and trabecular bone of the femur of patients with vertebral fractures by 3D-DXA. ASBMR 2017 Annual Meeting.
84. Del Río Barquero LM, *et al.* Finite Element Analysis of 3D-Shaper Femur Reconstructions to Predict Hip Fracture. ASBMR 2017 Annual Meeting.
85. Del Río Barquero LM, Di Gregorio S, Sanchez P. Bone structural components and lean mass assessed by 3D-DXA in Hip Fracture Patients. ASBMR 2016 Annual Meeting.
86. Humbert L, *et al.* Cortical and Trabecular Bone Analysis of Patients with Hip Fracture and Controls using 3D-DXA. WCO-IOF-ESCEO 2015.
87. Humbert L, *et al.* Vertebral Fracture Risk using a 3D Reconstruction Method from DXA. WCO-IOF-ESCEO 2015.
88. Bagué A, *et al.* Discrimination of hip fracture in postmenopausal women using a 3D reconstruction method from 2D DXA. WCO-IOF-ESCEO 2014.
89. Bagué A, *et al.* Discrimination of Hip Fracture event using a 3D reconstruction method from 2D DXA. A case control study. CARS 2014.
90. Whitmarsh T, *et al.* Hip Fracture Discrimination from Dual-energy X-ray Absorptiometry by Statistical Model Registration. Bone, 2012 Nov;51(5):896-901. DOI : 10.1016/j.bone.2012.08.114.
91. Whitmarsh T, *et al.* A Statistical Model of Shape and Bone Mineral Density Distribution of the Proximal Femur for Fracture Risk Assessment. Medical Imaging Computing and Computer Assisted Intervention (MICCAI), 2011, 14 (Pt 2):393-400. DOI : 10.1007/978-3-642-23629-7_48.
92. Whitmarsh T, *et al.* Hip Fracture Discrimination using 3D Reconstructions from Dual-energy X-ray Absorptiometry. ISBI 2011.
93. Whitmarsh T, *et al.* A Statistical Model of Shape and Bone Mineral Density Distribution of the Proximal Femur for Fracture Risk Assessment. MICCAI 2011.

Treatment Monitoring

94. Boxberger, J. *et al.* Abaloparatide Increases Bone Mineral Density in Regions Corresponding to Gruen Zones 1,2,6 and 7 in Postmenopausal Women with Osteoporosis. ISCD Annual Meeting 2023.
95. Boxberger, J. *et al.* Effects of Abaloparatide or Placebo on Bone Mineral Density in Acetabular Regions Corresponding to DeLee and Charnley Zones in Postmenopausal Women with Osteoporosis. ISCD Annual Meeting 2023.
96. Lewiecki, M. et al. Comparison of Romosozumab and Teriparatide Effects on Cortical and Trabecular Bone Using 3D Modeling From DXA Images in Postmenopausal Women Transitioning From Bisphosphonate Therapy. ASBMR Annual Meeting 2022.
97. Lewiecki, M. et al. Cortical and Trabecular Bone Improvements With Romosozumab Followed by Denosumab or Alendronate Assessed Using 3D Modeling From DXA Images. ASBMR Annual Meeting 2022.
98. Goel, H., Winzenrieth, R., Humbert, L., Borchardt, G., Binkley, N. Compared with Daily Teriparatide, Cyclic Teriparatide and Raloxifene Has Favorable Effects on Proximal Femur Geometry and Regional Volumetric BMD. ASBMR Annual Meeting 2022.
99. Tanaka, I. *et al.* Examination of bone structure related to changes in the proximal femur before and after Romosozumab treatment measured by 3D-Shaper and HR-pQCT. Japanese College of Rheumatology Annual Meeting 2022.
100. Suzuki, Y. *et al.* Analysis of the proximal femur structural analysis (HSA) using DXA and 3D-Shaper in patients treated with Romosozumab. Japanese College of Rheumatology Annual Meeting 2022.
101. Tanaka, I. *et al.* Investigation of bone structure related to the therapeutic effect of Romosozumab. Japanese College of Rheumatology Annual Meeting 2022.
102. Asada, T. *et al.* Investigation of bone mass changes after Romosozumab administration using DXA image analysis software 3D-SHAPER. JOS Annual Meeting 2022.
103. Ruiz Wills, M. *et al.* Evaluation of pharmacological treatments for osteoporosis using dxa-based 3d finite element models. European Society of Biomechanics 2022.
104. Qasim, M., Wills, C., Winzenrieth, R., Di Gregorio, S., Del Rio, L., Humbert, L., Noailly, J. Effects of osteoporosis pharmacological treatments on bone strength using 3D-Shaper based finite element analyses. QMSKI 2022.
105. Qasim, M., Wills, C., Winzenrieth, R., Di Gregorio, S., Del Rio, L., Humbert, L., Noailly, J. Effects of osteoporosis drug treatments on femur strength using 3D-Shaper based finite element analyses. WCO-IOF-ESCEO 2022.
106. Winzenrieth, R., Kostenuik, P., Boxberger, J., Wang, Y. and Humbert, L. Proximal Femur Responses to Sequential Therapy with Abaloparatide Followed by Alendronate in Postmenopausal Women with Osteoporosis by 3D Modeling of Hip DXA. JBMR Plus, 2022 Jan, Accepted Author Manuscript e10612. DOI : 10.1002/jbm4.10612
107. R. Winzenrieth, L. Humbert, J.I. Boxberger, R.J. Weiss, Y. Wang, P. Kostenuik. Abaloparatide Effects on Cortical Volumetric BMD and Estimated Strength Indices of Hip Subregions by 3D-DXA in Women with Postmenopausal Osteoporosis. J Clin Densitom. 2021 Aug 31st, JOCD 1292, S1094-6950(21)00098-6. DOI : 10.1016/j.jocd.2021.11.007.
108. M. Lopez Picazo, L. Humbert, R. Winzenrieth, D. Black. The effects of Parathyroid hormone and alendronate alone or in combination on trabecular and cortical bone using DXA-based 3D- modelling. ASBMR 2021 Annual Meeting.
109. Winzenrieth R, *et al.* Differential effects of abaloparatide and teriparatide on hip cortical volumetric BMD by DXA-based 3D modeling. Osteoporos Int. 2021 Jan 26. DOI : 10.1007/s00198-020-05806-1
110. Tomoaki Kato, Motokazu Kai, Ikuko Tanaka, et.al. Investigation of therapeutic effect of Romosozumab using 3D – SHAPER. JOS & JSBMR 2021.
111. Yohei Asada, et.al. Change of bone mass after 1 year treatment with Romosozumab evaluated by 3D-SHAPER, a novel image analysis software. JOS & JSBMR 2021.

112. Hiroaki Mizuno, Motokazu Kai, Ikuko Tanaka, et.al. Evaluation of hip structure using 3D-SHAPER in patients with severe osteoporosis treated by Romosozumab. JOS & JSBMR 2021.
113. Lopez Picazo M., Humbert L., Winzenrieth R., Black D. M. Efectos del tratamiento con hormona paratiroidea y alendronato, solos o en combinación, en la densidad volumétrica trabecular y cortical evaluados mediante modelos 3D-DXA. SEIOMM 2021.
114. M. Lopez Picazo, L. Humbert, R. Winzenrieth, D. Black. The effects of Parathyroid hormone and alendronate alone or in combination on trabecular and cortical bone using DXA-based 3D- modelling. SEIOMM 2021.
115. Winzenrieth R, *et al*. Heterogeneity in the cortical response to abaloparatide and teriparatide in the proximal femur by DXA-based 3D modeling. ASBMR2020 Annual Meeting.
116. Pasha P, *et al*. Greater increase of hip trabecular vBMD by 3D modeling of hip DXA in patients treated with denosumab as compared to bisphosphonates. WCO-IOF-ESCEO 2020.
117. Winzenrieth R, *et al*. Differential effects of abaloparatide and teriparatide on cortical volumetric BMD and bone strength indices in the proximal femur by DXA-based 3D modeling. WCO-IOF-ESCEO 2020.
118. Winzenrieth R, *et al*. Differential Effects of Abaloparatide and Teriparatide on Hip Cortical Volumetric BMD by DXA-Based 3d Modeling. ENDO 2020.
119. Arboiro Pinel R, *et al*. Efectos del tratamiento con denosumab en 3D-DXA. SEIOMM 2019.
120. Tomatsu E, *et al*. Analysis of 2D-DXA image by 3D-SHAPER gives additional information for the treatment with denosumab in post-kidney transplant recipients. ASBMR2019 Annual Meeting.
121. Goel H, Krueger D, Borchardt G, Binkley N. Compared with Daily Teriparatide, Cycles of Teriparatide and Raloxifene Favorably Influence Hip BMD and Cortical Thickness While Comparably Increasing Spine BMD. ASBMR2019 Annual Meeting.
122. Tomatsu E, *et al*. DXA-based 3D modeling using 3D-SHAPER gives additional information in post-kidney transplant patient treated with denosumab. ASBMR2019 Annual Meeting.
123. Almohaya M, Winzenrieth R, Kendler D. The Distribution of Increases in Hip Cortical Volumetric BMD in Patients Treated with Denosumab and Bisphosphonates by 3D Modeling of Hip DXA. WCO-IOF-ESCEO 2019.
124. Guagnelli M, *et al*. Tibolone effect on bone components using 3D-Shaper technology compared to hormone replacement therapy and placebo in postmenopausal women. WCO-IOF-ESCEO 2019.
125. Kendler D, Almohaya M, Sami N, Winzenrieth R. Greater increases of cortical and trabecular vBMD by 3D modeling of hip DXA in patients treated with Dmab vs bisphosphonates (extension of study with 4Y monitoring). WCO-IOF-ESCEO 2019.
126. Winzenrieth R, *et al*. Effects of osteoporosis drug treatments on cortical and trabecular bone in the femur using DXA-based 3D modeling. Osteoporos Int. 2018 Oct;29(10):2323-2333. DOI : 10.1007/s00198-018-4624-4.
127. Nogués X, *et al*. Trabecular and cortical bone health in postmenopausal women receiving aromatase inhibitors for early breast cancer treatment: The B-ABLE prospective cohort study. SEIOMM 2018.
128. Cons-Molina F, *et al*. Respuesta ósea cortical y trabecular en fémur proximal de mujeres con osteoporosis tratadas con Denosumab utilizando técnicas de modelado 3D obtenidas por DXA. AAOMM-SAO 2018.
129. Almohaya M, Sami N, Winzenrieth R, Kendler D. 3D Modelling of hip DXA indicates cortical vBMD superior efficacy of denosumab versus alendronate. ASBMR 2018 Annual Meeting.
130. Cons Molina F, *et al*. Cortical and Trabecular Bone Response in Proximal Femur from Women with Osteoporosis Treated with Denosumab or Zolendronic Acid using 3D Modelling Techniques obtained from DXA. ASBMR 2018 Annual Meeting.
131. Almohaya M, *et al*. Hip DXA 3D Modeling Shows Increased Cortical Bone Density after treatment with Denosumab versus Bisphosphonate in Postmenopausal Women. WCO-IOF-ESCEO 2018.
132. Cons Molina FF, *et al*. Cortical and Trabecular Bone Response in Proximal Femur from Women with Osteoporosis Treated with Denosumab or Zolendronic Acid using 3D Modelling Techniques Obtained from DXA. PANLAR 2018.
133. Winzenrieth R, *et al*. Cortical and trabecular compartments behavior in patients under bone treatments using 3D parameters obtained from DXA. SEIOMM 2017.

134. López Picazo M, *et al*. Changes in volumetric BMD and cortical thickness measured by 3D-DXA in the lumbar spine after 24 months of Denosumab treatment. ASBMR 2017 Annual Meeting.
135. Winzenrieth R, *et al*. Cortical and trabecular compartments behaviour in patients under bone treatments using 3D parameters obtained from DXA. ASBMR 2017 Annual Meeting.
136. Güerri-Fernandez R, *et al*. Analyzing the cortical and trabecular bone of tenofovir-treated HIV patients using 3D-DXA. WCO-IOF-ESCEO 2017.
137. Güerri-Fernandez R, *et al*. Bone density, microarchitecture, and bone strength after 1 year of TDF. CROI 2017 - Conference on Retroviruses and Opportunistic Infections.
138. Güerri-Fernández R, *et al*. Analyzing the cortical and trabecular bone of tenofovir-treated HIV patients using 3D-DXA. ASBMR 2016 Annual Meeting.
139. Malouf J, *et al*. Cortical and Trabecular Bone Mineral Content changes at the Proximal Femur assessed by 3D-DXA after PTH (1-84) treatment. WCO-IOF-ESCEO 2015.
140. Del Río Barquero LM, Di Gregorio S, Martelli Y, Humbert L. Volumetric Bone Mineral Content changes assessed by 3D-DXA after two years of Denosumab Treatment. WCO-IOF-ESCEO 2015.
141. Malouf J, *et al*. Cambios en el contenido mineral óseo cortical y trabecular en el fémur proximal evaluados por 3D-DXA tras tratamiento con PTH (1-84). SEIOMM 2015.
142. Del Río Barquero LM, Di Gregorio S, Humbert L, Martelli Y. Volumetric Bone Mineral Content changes assessed by 3D-DXA after two years of Alendronate Treatment. ASBMR 2014 Annual Meeting.
143. Del Río Barquero LM, Di Gregorio S, Humbert L, Martelli Y. Cambios de densidad mineral ósea volumétrica tras dos años de tratamiento con Alendronato evaluado por 3D-DXA. SEIOMM 2014.

Secondary Osteoporosis

144. Kai, K. *et al.* **Investigation of bone microstructure of the proximal femur of patients with Rheumatoid Arthritis using 3D-Shaper.** Japanese College of Rheumatology Annual Meeting 2022.
145. Borba, V., Winzenrieth, R., Humbert, L., Nalevaiko, J., Aguilar Moreira, C. **Effect of the anticoagulants (DOACS) on cortical and trabecular bone in the femur using DXA-based 3D modeling.** WCO-IOF-ESCEO 2022.
146. Kužma M, Vaňuga P, Ságová I, Pávai D, Jackuliak P, Killinger Z, Binkley NC, Winzenrieth R, Genant HK, Payer J. **Vertebral Fractures Occur Despite Control of Acromegaly and Are Predicted by Cortical Volumetric Bone Mineral Density.** J Clin Endocrinol Metab. 2021 Jul 16;dgab259. DOI : 10.1210/clinem/dgab259.
147. Atencio P. *et al.* **Trabecular bone score and 3D-DXA in young, antiretroviral treatment-naïve patients in Madrid.** Arch Med Sci Civil Dis 2021; 6: e52–e60. DOI: https://doi.org/10.5114/amscd.2021.105843.
148. Rosa Arboiro-Pinel, Ignacio Mahíllo-Fernández, Manuel Díaz-Curiel. **Bone Analysis Using Trabecular Bone Score and Dual-Energy X-Ray Absorptiometry-Based 3-Dimensional Modeling in Postmenopausal Women With Primary Hyperparathyroidism.** Endocr Pract. 2021 Aug 25;S1530-891X(21)01177-0. DOI : 10.1016/j.eprac.2021.08.006.
149. Toussirot E, Winzenrieth R, Desmarets M, et al. **AB0570 Bone Mineral Density, Trabecular Bone Score and Proximal Femur 3D-DXA Analysis In Psoriatic Diseases**. Annals of the Rheumatic Diseases 2021;80:1322.
150. Maïmoun L, *et al.* **Modification of bone mineral density, bone geometry and volumetric BMD in young women with obesity.** Bone. 2021 May 14;150:116005. DOI : 10.1016/j.bone.2021.116005.
151. Costa R, *et al.* **Volumetric BMD by 3D-DXA and Trabecular Bone Score in Adults With Down Syndrome.** J Clin Densitom. 2021 Jan 30;S1094-6950(21)00011-1. DOI : 10.1016/j.jocd.2021.01.010.
152. Gracia-Marco LM, *et al.* **3D DXA Hip Differences in Patients with Acromegaly or Adult Growth Hormone Deficiency.** J Clin Med. 2021 Feb 9;10(4):657. DOI : 10.3390/jcm10040657.
153. Masahiro Yamamoto, et.al. **Lateral cortical bone of the femoral neck in type 2 diabetic patients with vertebral fractures is deteriorated.** JOS & JSBMR 2021.
154. Motokazu Kai, Ikuko Tanaka. **Effects of glucocorticoids on hip trabecular and cortical bone by using 3D-SHAPER.** JOS & JSBMR 2021.
155. A.P Barbosa, M.R. Mascarenhas, R. Winzenrieth. **Hyperthyroid men have reduced global strength of the proximal femur in 3D-Shaper analysis.** WCO-IOF-ESCEO 2021.
156. M.R. Ulla, C. Vrech, L.R. Brun, M.L. Brance, E. Peralta Lopez, M.J Castro, F. Martos, S. Mazzini, M.A. Rivoira. **Bone health in patients with multiple sclerosis: analysis of bone mineral density and 3D-Reconstruction of proximal femur by DXA.** WCO-IOF-ESCEO 2021.
157. M. L. Brance, *et al.* **Bone Mineral Density and Proximal Femur 3D-DXA Analysis in Type I Diabetes: Preliminary Study.** WCO-IOF-ESCEO 2021.
158. M. L. Brance, *et al.* **BMD and Proximal Femur 3D-DXA Analysis in Systemic Lupus Erythematosus and Spondyloarthritis.** WCO-IOF-ESCEO 2021.
159. Tornero C, *et al.* **Evaluation of bone mineral density and 3D-Shaper parameters in congenital hypophosphatasia of the adult.** Rev Osteoporos Metab Miner. 2020; 12 (4): 129-134. DOI : 10.4321/S1889-836X2020000400004.
160. Gil-Cosano JJ, *et al.* **The effect of an online exercise programme on bone health in paediatric cancer survivors (iBoneFIT): study protocol of a multi-centre randomized controlled trial.** BMC Public Health. 2020 Oct 8;20(1):1520. DOI : 10.1186/s12889-020-09607-3.
161. Brance ML, *et al.* **Trabecular and cortical bone involvement in rheumatoid arthritis by DXA and DXA-based 3D modelling.** Osteoporos Int. 2020 Sep 24. DOI : 10.1007/s00198-020-05641-4.
162. Campillo-Sánchez F, *et al.* **Relationship Between Insulin Resistance (HOMA-IR), Trabecular Bone Score (TBS), and Three-Dimensional Dual-Energy X-ray Absorptiometry (3D-DXA) in Non-Diabetic Postmenopausal Women.** J Clin Med. 2020 Jun 3;9(6):E1732. DOI : 10.3390/jcm9061732.

163. Gracia-Marco LM, *et al*. Analysis of bone impairment by 3D DXA hip measures in patients with primary hyperparathyroidism: a pilot study. J Clin Endocrinol Metab 2020 Jan 1;105(1). DOI : 10.1210/clinem/dgz060.
164. Toussirot E, *et al*. Bone mineral density, trabecular bone score and proximal femur 3D-DXA analysis in psoriatic diseases. ASBMR2020 Annual Meeting.
165. Yoshino Y, *et al*. Comparison of hip structure analysis and 3D-Shaper® images in post-kidney transplant recipients with denosumab treatment. ASBMR2020 Annual Meeting.
166. Muñoz-Torres M, *et al*. Analysis of bone status by 3D DXA measures in patients with acromegaly or growth hormone deficiency. ASBMR2020 Annual Meeting.
167. Olascoaga-Gómez de León A, *et al*. Hip structural analysis and advanced glycation end products in patients with diabetes. WCO-IOF-ESCEO 2020.
168. Di Gregorio S, Karlsbrum S, Costanzo P, Salerni H. 3D Shaper evaluation in normo and hypercalcemic primary hyperparathyroidism. WCO-IOF-ESCEO 2020.
169. Mascarenhas M, Barbosa A, Winzenrieth R. Impact of the serum circulating 25-hydroxyvitamin D levels and lean body mass on cortical and trabecular bone at the proximal femur of adult men using 3D analysis. WCO-IOF-ESCEO 2020.
170. Casado E, *et al*. Usefulness of 3D-DXA in assessing fracture risk in 104 male patients with chronic obstructive pulmonary disease. .WCO-IOF-ESCEO 2020.
171. Barbosa A, Mascarenhas M, Winzenrieth R. Trabecular and cortical bone measurements by 3D-Shaper in men with hyperthyroidism. WCO-IOF-ESCEO 2020.
172. Rui Mascarenhas M, Barbosa A, Winzenrieth R. Testosterone, estradiol and 25-hydroxyvitamin D effects at the proximal femur in 3D analysis from a standard 2D DXA scans of adult men. EECE 2020.
173. Kužma M, *et al*. Non-invasive DXA-derived bone structure assessment of acromegaly patients: a cross-sectional study. Eur J Endocrinol. 2019 Mar 1;180(3):201-211. DOI : 10.1530/EJE-18-0881.
174. García Hoyos M, *et al*. Analysis of volumetric BMD in people with Down syndrome using DXA-based 3D modeling. Arch Osteoporos. 2019 Sep 7;14(1):98. DOI : 10.1007/s11657-019-0645-7.
175. Tornero C, *et al*. Bone mineral density and 3D DXA assessment in adult patients with a positive and negative genetic testing for hypophosphatasia compared with a healthy control group. SEIOMM 2019.
176. Casado E, *et al*. Utilidad de la 3D-DXA en la valoración del riesgo de fractura en pacientes varones con enfermedad pulmonar obstructiva crónica. SEIOMM 2019.
177. Tornero C, *et al*. Evaluación densitométrica y mediante 3D-Shaper de pacientes adultos con fosfatasa alcalina baja persistente y test genético positivo y negativo para hipofosfatasia en comparación con un grupo de controles sanos. SEIOMM 2019.
178. Campillo-Sánchez F, *et al*. Asociación entre resistencia a la insulina (homa), trabecular bone score (TBS) y 3D-DXA en mujeres postmenopáusicas no diabéticas. SEIOMM 2019.
179. Campillo-Sánchez F, *et al*. Asociación entre ácido úrico, trabecular bone score (TBS) y 3D-DXA en mujeres postmenopáusicas. SEIOMM 2019.
180. García-Fontana B, *et al*. Contribución de DXA-3D en la evaluación de la afectación ósea en pacientes con hiperparatiroidismo primario. SEIOMM 2019.
181. Barceló-Bru M, *et al*. Estudio de los compartimentos cortical y trabecular mediante 3D-Shaper en pacientes trasplantados pulmonares. SEIOMM 2019.
182. Tornero C, *et al*. Bone mineral density and 3d-dxa assessment in adult patients with a positive and negative genetical testing for hypophosphatasia compared with a healthy control group. ASBMR2019 Annual Meeting.
183. García-Fontana B, *et al*. Structural Parameters of Proximal Femur by 3D Dual-Energy X-ray Absorptiometry in Patients with Primary Hyperparathyroidism. ASBMR2019 Annual Meeting.
184. Gundry M, *et al*. 3D Shape Modelling Analysis of the Hip using 3D-SHAPER Software – A Comparison Between Contralateral, Ipsilateral, and Baseline Hips for RTKR, TKR, and Control Participants. ASBMR2019 Annual Meeting.
185. Barcelo-Bru M, Erra A, Espinet C. Study of cortical and trabecular compartments through 3d-shaper in lung transplanted patients. ECTS 2019.

186. Mascarenhas M, *et al*. Impact of hypogonadism on both cortical and trabecular compartments at the proximal femur using 3D DXA modeling approach. WCO-IOF-ESCEO 2019.
187. Usategui R, *et al*. Association between insulin resistance (HOMA), trabecular bone score (TBS) and DXA-derived 3D measurements of the cortical and trabecular bone in nondiabetic postmenopausal women. WCO-IOF-ESCEO 2019.
188. Humbert L, *et al*. Changes in Femoral cortical and trabecular bone after bariatric surgery. WCO-IOF-ESCEO 2019.
189. Barceló-Bru M, Erra A, Espinet C. Study of cortical and trabecular compartments through 3D-SHAPER in lung transplanted patients. WCO-IOF-ESCEO 2019.
190. Nogués X, *et al*. Trabecular and cortical bone health in postmenopausal women receiving aromatase inhibitors for early breast cancer treatment: the B-ABLE prospective cohort study. WCO-IOF-ESCEO 2019.
191. Usategui R, *et al*. Association between insulin resistance (HOMA), trabecular bone score (TBS) and DXA-derived 3D measurements of the cortical and trabecular bone in nondiabetic postmenopausal women. WCO-IOF-ESCEO 2019.
192. Gifre L, *et al*. Analysis of the evolution of cortical and trabecular bone compartments in the proximal femur after spinal cord injury by 3D-DXA. Osteoporos Int. 2018 Jan;29(1):201-209. DOI : 10.1007/s00198-017-4268-9.
193. Orduna G, *et al*. Cortical and Trabecular Bone Analysis of Patients With High Bone Mass From the Barcelona Osteoporosis Cohort Using 3-Dimensional Dual-Energy X-ray Absorptiometry: A Case-Control Study. J Clin Densitom. 2018 Oct - Dec;21(4):480-484. DOI : 10.1016/j.jocd.2017.05.012.
194. Valero C, *et al*. Estudio de la densidad mineral osea volumetrica en la cohorte CAMARGO: diferencias relacionadas con la edad y sexo. SEIOMM 2018.
195. Tornero C, *et al*. Evaluación de la densidad mineral ósea volumetrica de pacientes adultos con hipofosfatasia del adulto comparada con pacientes con hipofosfatasemia persistente y estudio genético HPP negativo. SEIOMM 2018.
196. Montoya M, *et al*. Composición corporal y macro estructura de fémur proximal. SEIOMM 2018.
197. García Hoyos M, *et al*. Medición de la DMO volumétrica con métodos de modelado 3D a partir de la DXA-3D en personas con Síndrome de Down. SEIOMM 2018.
198. Cortés-Berdonces M, *et al*. Análisis 3D de hueso cortical y trabecular en pacientes con diabetes mellitus tipo 2. SEIOMM 2018.
199. Brance M, *et al*. Utilidad clínica de la reconstrucción 3D a partir de densitometría de cadera en pacientes con artritis reumatoide tratados con diferentes esquemas terapéuticos. Datos preliminares. AAOMM-SAO 2018.
200. Manasanch Berengué A, Winzenrieth R, Humbert L, Leib E. Low daily dose of glucocorticoids induces trabecular and cortical bones impairment at the femur: a 3D analysis using DXA-based modelling. ASBMR 2018 Annual Meeting.
201. Winzenrieth R, Humbert L, Leib E. Assesment of chronic kidney disease impact at the proximal femur using a DXA-based 3D modelling approach. WCO-IOF-ESCEO 2018.
202. Gifre L, *et al*. Análisis de la evolución de los compartimientos cortical y trabecular en fémur proximal mediante 3D-DXA en pacientes con lesión medular. SEIOMM 2017.
203. Gifre L, *et al*. Analysis of the evolution of cortical and trabecular bone compartments in the proximal femur after spinal cord injury by 3D-DXA. ASBMR 2017 Annual Meeting.
204. Almohaya M, *et al*. Volumetric Hip DXA Indicates Rapid Deterioration of Both Cortical and Trabecular Bone Compartments After Allogeneic Hematologic Stem Cell Transplant. ASBMR 2017 Annual Meeting.
205. Koumakis E, *et al*. 3D femur assessment using DXA in patients with primary hyperparathyroidism (PHPT) before and one year after parathyroidectomy. ASBMR 2017 Annual Meeting.
206. Gifre L, *et al*. Analysis of the evolution of cortical and trabecular bone compartments in the proximal femur after spinal cord injury by 3D-DXA. EULAR 2017.
207. Gifre L, *et al*. Analysis of the evolution of cortical and trabecular bone compartments in the proximal femur after spinal cord injury by 3D-DXA. ECTS 2017.

208. Clark P, *et al*. Effectiveness of 3D-DXA as a tool to differentiate bone components in two models of diabetes compared to controls. WCO-IOF-ESCEO 2017.
209. Guglielmi G, *et al*. Primary hyperparathyroidism (PHPT) impaired 3D cortical density at femur as assessed from 2D DXA. WCO-IOF-ESCEO 2017.
210. Zanchetta MB, *et al*. 3D-DXA analysis of the changes in cortical and trabecular bone in patients with celiac disease after 1-year on gluten-free diet. ASBMR 2016 Annual Meeting.
211. Humbert L, *et al*. Analyzing the cortical and trabecular bone of type 1 diabetes patients using 3D-DXA – a longitudinal study. ASBMR 2016 Annual Meeting.
212. Nogués X, *et al*. Cortical and Trabecular Bone Analysis of Patients with Early Breast Cancer under Aromatase Inhibitors, B-ABLE Cohort, using 3D-DXA: a Longitudinal Study. WCO-IOF-ESCEO 2016.
213. Rodriguez-Morera J, *et al*. Cortical and Trabecular Bone Analysis of Patients with High Bone Mass from the BARCOS Cohort using 3D-DXA: A Case–Control Study. WCO-IOF-ESCEO 2016.
214. Guagnelli MA, *et al*. Cortical and trabecular bone analysis with 3D-DXA in patients with Type 2 Diabetes, Long Latent Autoimmune Diabetes in adults (LADA) and healthy controls: a preliminary report. WCO-IOF-ESCEO 2016.
215. Bagué A, *et al*. Cortical and Trabecular Bone Analysis of Hip Fracture Patients using 3D-DXA. ASBMR 2015 Annual Meeting.
216. Del Río Barquero LM, *et al*. Functional muscle-bone unit assessed by 3D-DXA: Study in a cohort of postpolio syndrome patients. ASBMR 2015 Annual Meeting.
217. Del Río Barquero LM, *et al*. Assessment of sequels of Poliomyelitis in hips by 3D-DXA. WCO-IOF-ESCEO 2015.
218. Del Río Barquero LM, *et al*. Sindrome funcional post-polio, estudio DXA-3D y composición corporal. SEIOMM 2015.
219. Malouf J, *et al*. Estudio volumétrico del hueso trabecular y cortical en pacientes acromegálicos mediante 3D-DXA. SEIOMM 2015.

Sport, exercise, muscle & bone

220. Amani A, *et al.* Femur 3D-DXA assessment in femail football players, swimmers and sedentary controls. Int J Sports Med. Aug 2022. DOI : 10.1055/a-1928-9824.
221. O'Rourke D, *et al.* Assessment of femoral neck strength and bone mineral density changes following exercise using 3D-DXA images. J Biomech. 2021 Feb 9;119:110315. DOI : 10.1016/j.jbiomech.2021.110315.
222. Harding A, *et al.* Effects of Supervised High-Intensity Resistance and Impact Training or Machine-Based Isometric Training on Regional Bone Geometry and Strength in Middle-Aged and Older Men With Low Bone Mass: The LIFTMOR-M Semi-Randomised Controlled Trial. Bone. 2020 Jul;136:115362. DOI : 10.1016/j.bone.2020.115362.
223. Lambert C, *et al.* Regional Changes in Indices of Bone Strength of Upper and Lower Limbs in Response to High-Intensity Impact Loading or High-Intensity Resistance Training. Bone. 2020 Mar;132:115192. DOI : 10.1016/j.bone.2019.115192.
224. Ng CA, *et al.* Feasibility, safety and effectiveness of a pilot 16-week home-based, high-impact exercise intervention in post-menopausal women with low bone mineral density. ASBMR2020 Annual Meeting.
225. Ng CA, *et al.* Feasibility, safety and effectiveness of a 16-week home-based hopping and jumping pilot exercise intervention in post-menopausal women with low bone mineral density. WCO-IOF-ESCEO 2020.
226. Ng CA, *et al.* Associations between physical activity and bone structure in older adults: does the use of self-reported versus objective assessments of physical activity influence the relationship? Osteoporos Int. 2019, 31(3):493-503. DOI : 10.1007/s00198-019-05208-y.
227. Gandham A, *et al.* Associations of Health-Related Quality of Life, Fear of Falling and Objective Measures of Physical Function with Bone Health in Postmenopausal Women with Low Bone Mass. J Clin Med. 2019 Sep 2;8(9). DOI : 10.3390/jcm8091370.
228. Freitas L, *et al.* Cortical and trabecular bone analysis of professional dancers using 3D-DXA: a case-control study. J Sports Sci. 2019 Jan;37(1):82-89. DOI : 10.1080/02640414.2018.
229. Watson SL, *et al.* High-Intensity Resistance and Impact Training Improves Bone Mineral Density and Physical Function in Postmenopausal Women With Osteopenia and Osteoporosis: The LIFTMOR Randomized Controlled Trial. J Bone Miner Res. 2018 Feb;33(2):211-220. DOI : 10.1002/jbmr.3284.
230. Humbert L, *et al.* 3D analysis of the cortical and trabecular bone of elite female athletes involved in high- and low-impact sports. SEIOMM 2018.
231. Humbert L, *et al.* 3D analysis of the cortical and trabecular bone of elite female athletes involved in high- and low-impact sports. ASBMR 2018 Annual Meeting.
232. Buehring B, *et al.* Relationship of muscle function and mass with DXA-derived 3D parameters. WCO-IOF-ESCEO 2018.
233. Humbert L, *et al.* 3D analysis of the cortical and trabecular bone of elite female athletes involved in high- and low-impact sports. WCO-IOF-ESCEO 2018.
234. Harding A, Weeks B, Watson S, Beck B. The LIFTMOR-M (Lifting Intervention For Training Muscle and Osteoporosis Rehabilitation for Men) trial: protocol for a semirandomised controlled trial of supervised targeted exercise to reduce risk of osteoporotic fracture in older men with low bone mass. BMJ Open. 2017 Jun 12;7(6):e014951. DOI : 10.1136/bmjopen-2016-014951.
235. Lambert C, *et al.* A protocol for a randomised controlled trial of the bone response to impact loading or resistance training in young women with lower than average bone mass: the OPTIMA-Ex trial. BMJ Open. 2017 Sep 1;7(9):e016983. DOI : 10.1136/bmjopen-2017-016983.
236. Pasqualini M, *et al.* 3D-DXA analysis showed that moderate to high-magnitude whole body vibration training over one year increased femoral cortical thickness in lowactive postmenopausal women. ASBMR 2016 Annual Meeting.
237. Amorim T, *et al.* Cortical and trabecular bone analysis of professional dancers using 3D-DXA: a case–control study. WCO-IOF-ESCEO 2016.

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