Quoi de neuf en imagerie? Utilisation de la tomographie périphérique à haute résolution

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Paris, 15 janvier 2016

Quoi de neuf en imagerie ?
Utilisation de l'HRpQCT

Etudes de physiopathologie osseuse

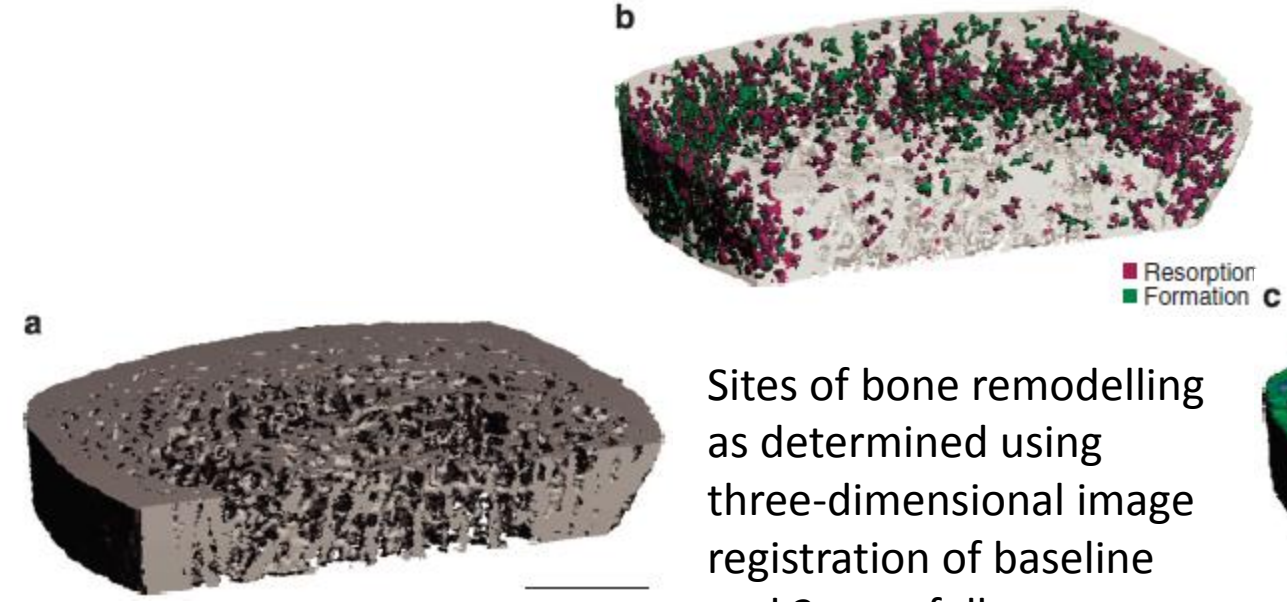
Etude de la prédiction du risque de fracture

Chez la femme ménopausée

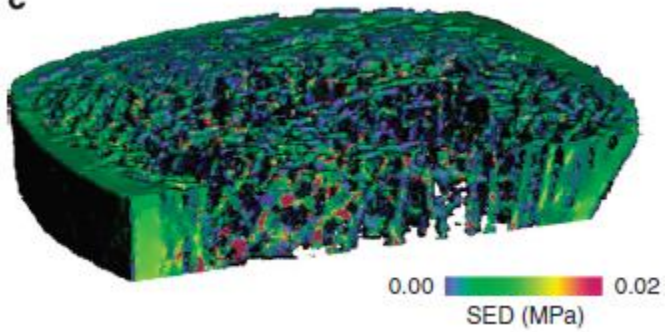
Dans l'insuffisance rénale chronique

Bone Remodeling in Humans is Load-Driven but not Lazy

Tibia measurements from 9 healthy postmenopausal women from OFELY, aged 59-80, 2 yr follow-up



Sites of bone remodelling as determined using three-dimensional image registration of baseline and 2-year follow-up measurements.



Cross-section of the human distal tibia as assessed with in vivo HR-pQCT.

Tissue loading represented as SED and calculated using micro-FE analysis.

Association between bone remodeling sites and local tissue loading

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Christen P, et al. Nat Commun 2014

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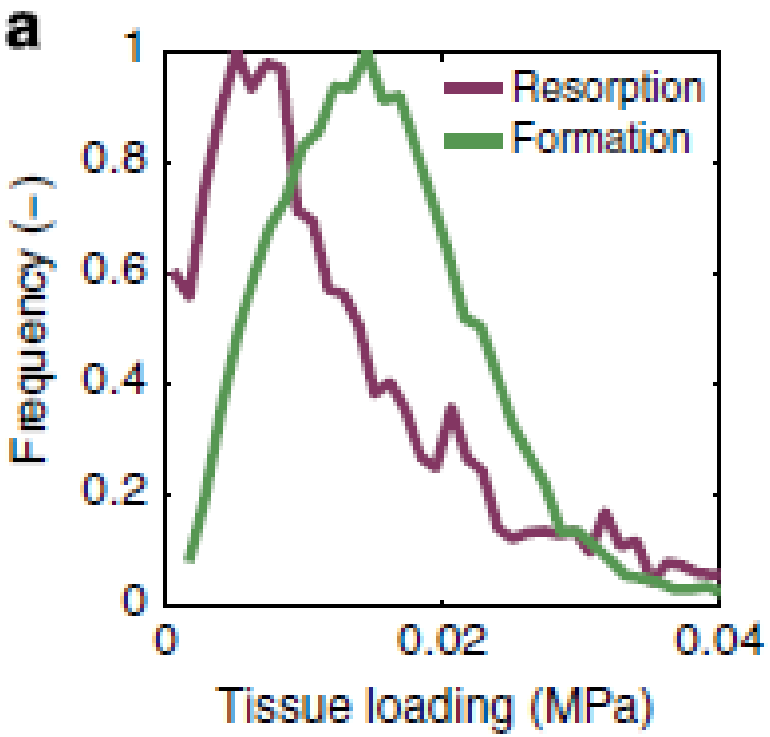
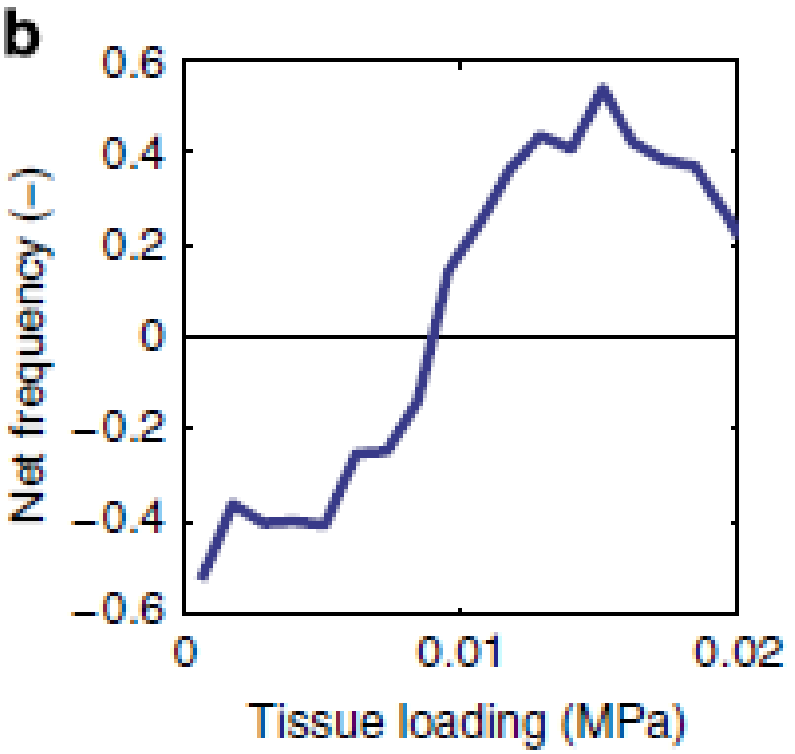


Tissue SED histograms in the regions of bone resorption and formation.



Relationship between bone remodelling and tissue loading quantified by subtracting the formation and resorption histograms.

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Christen P, et al. Nat Commun 2014

MultiXCT Study – Subjects Characteristics

Of 1379 post-menopausal Caucasian women, 470 (34%) had sustained at least one fracture (194 forearm, 178 vertebral, 35 humerus, 20 hip, 83 lower leg, 46 ribs, 61 metatarsal, 35 metacarpal)

	No fx (n=909)	Fx (n=470)	% difference fx vs. no fx	Difference range within centers
Age (yrs)	65 ± 8	69 ± 9	6.4% **	0.7% ; 11.1%
Height (cm)	159 ± 7	160 ± 7	0.4%	-0.7%; -0.2%
Weight (kg)	65 ± 12	68 ± 14	4.2% **	-3.3%; 5.6%
BMI (kg/m^2)	25.8 ± 4.7	26.6 ± 5.3	3.1%*	-2.6%; 6.2%
Total hip T-Score	-0.9 ± 1.0	-1.2 ± 1.0	-0.3SD **	-0.8SD; 0.1SD
Lumbar spine T-Score	-1.5 ± 1.3	-1.5 ± 1.4	0.0SD	-0.8SD; -0.1SD

* $p \leq 0.01$, ** $p \leq 0.001$

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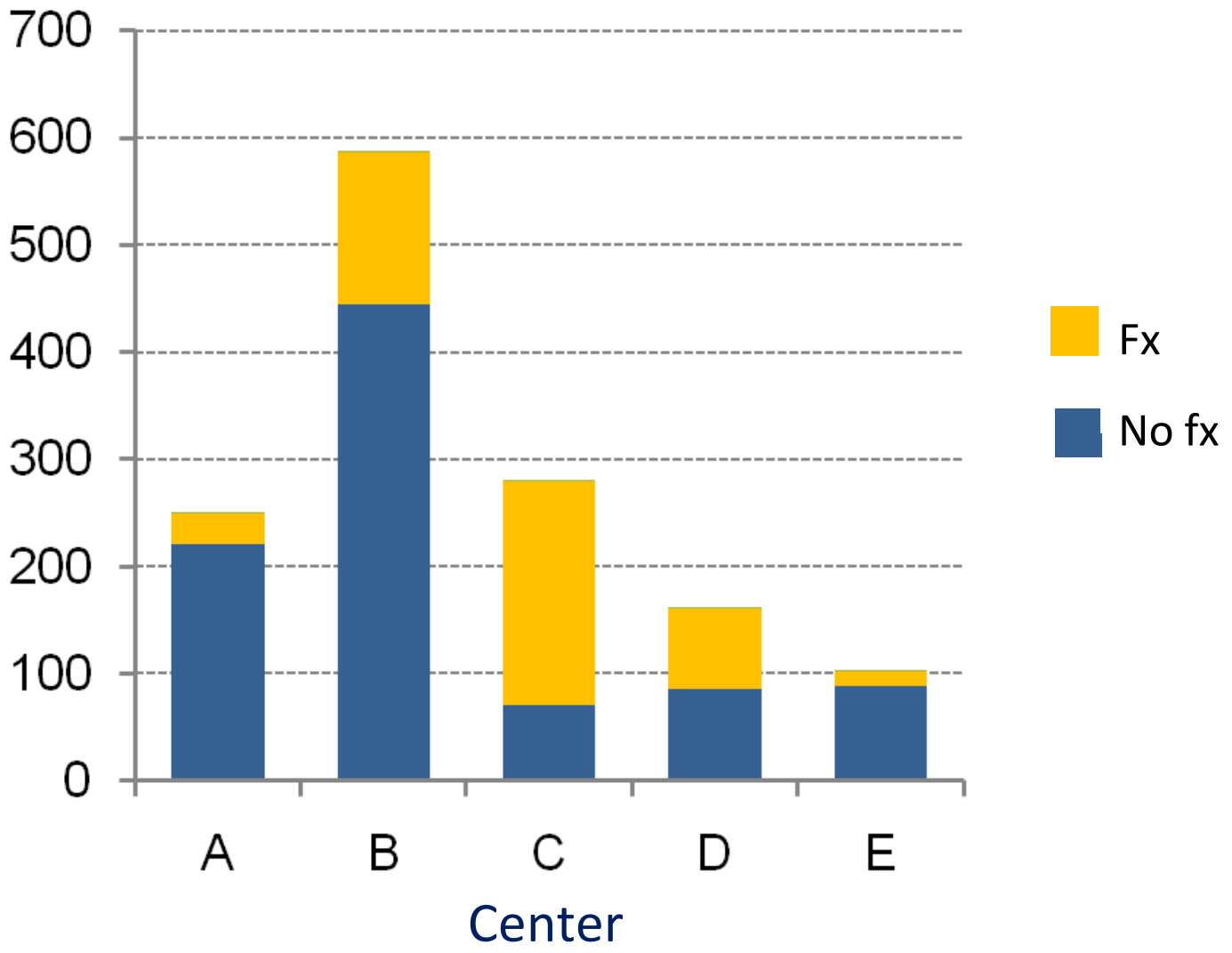
Sample Size by Fracture Status per Center



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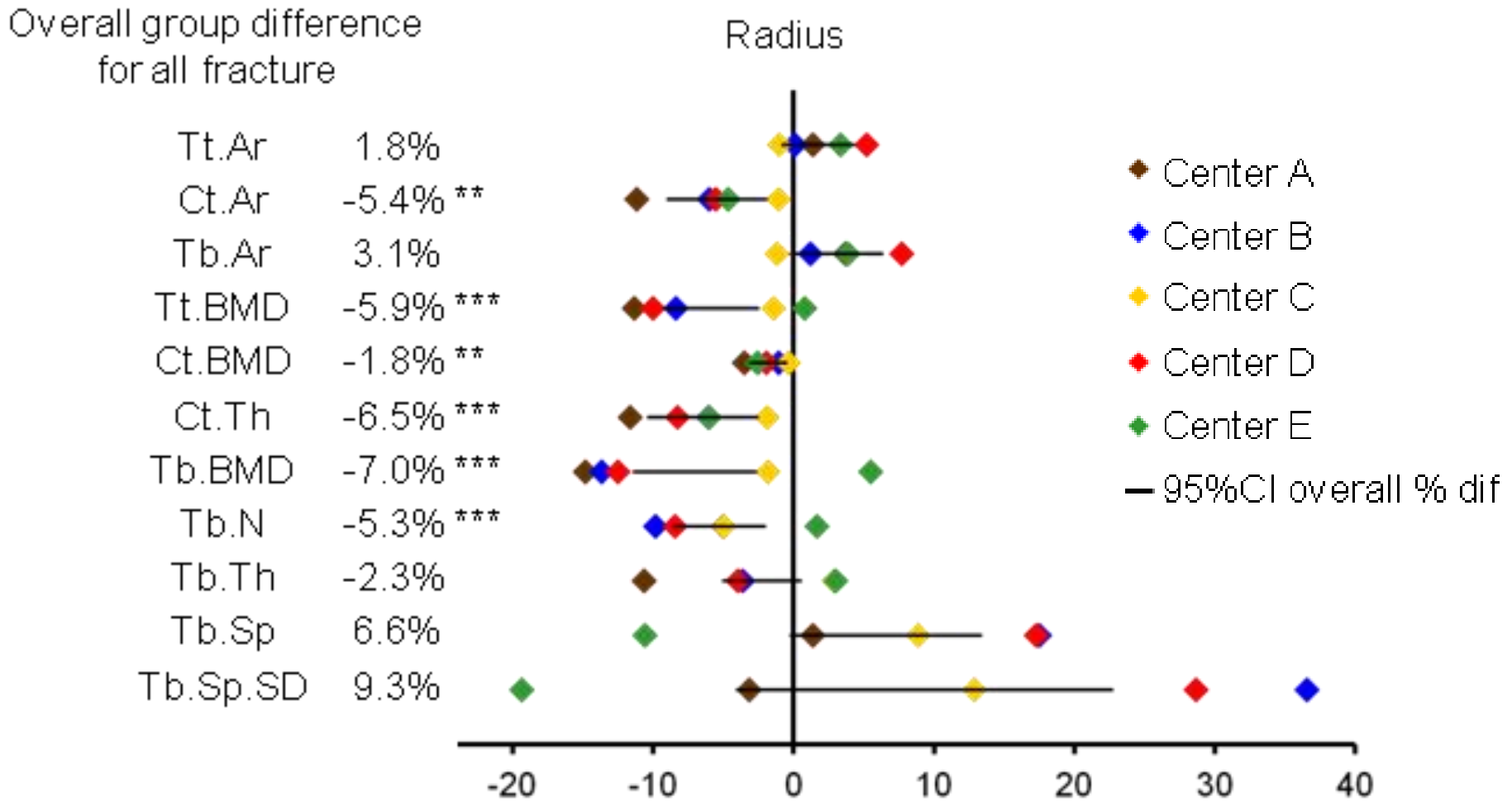
Overall and Within Center
% difference between ALL fx (n=470) and no fx



* p≤0.05, ** p≤0.01, *** p≤0.001 after adjustment for age, height, weight, total hip T-score and center

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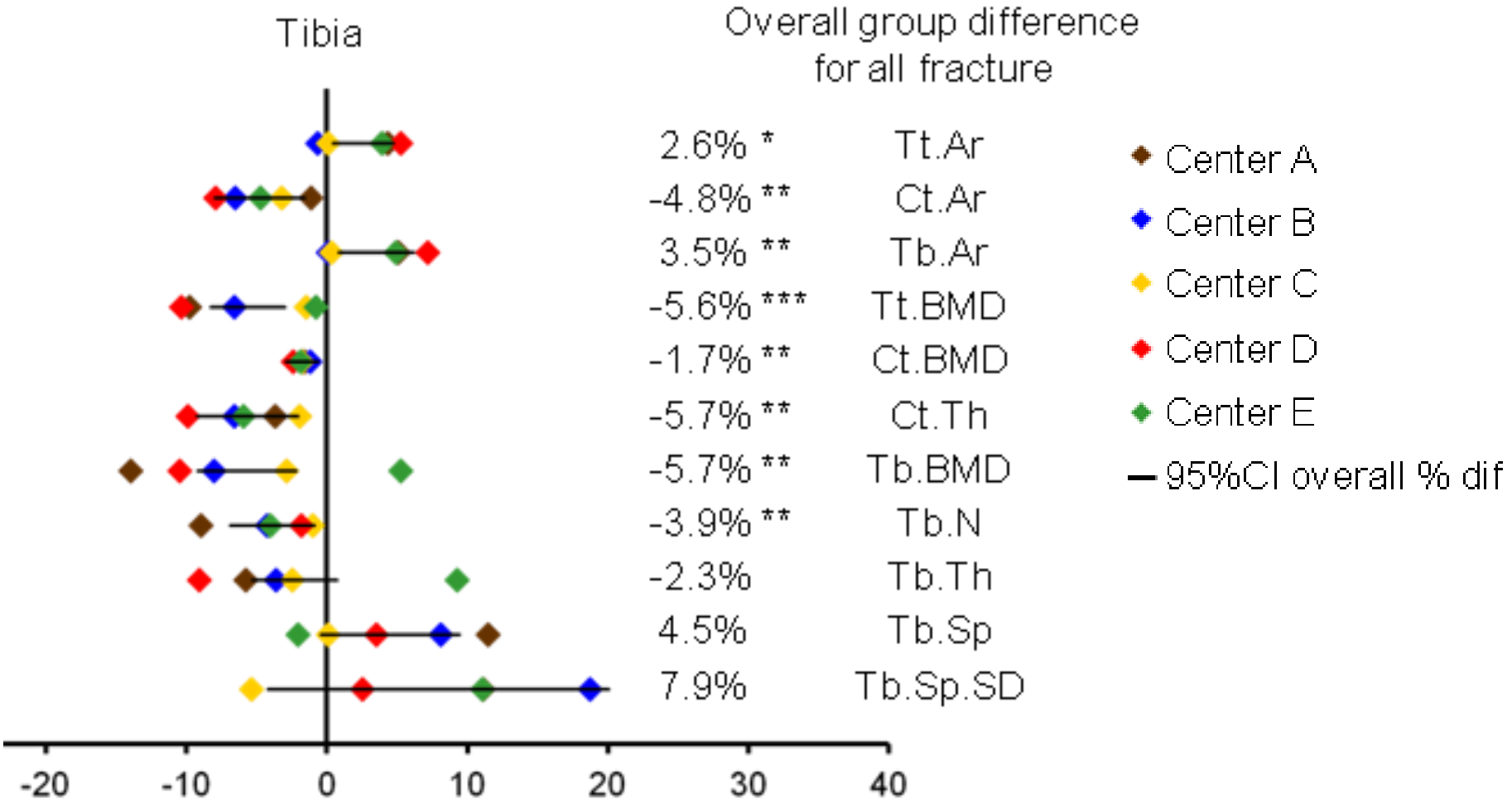

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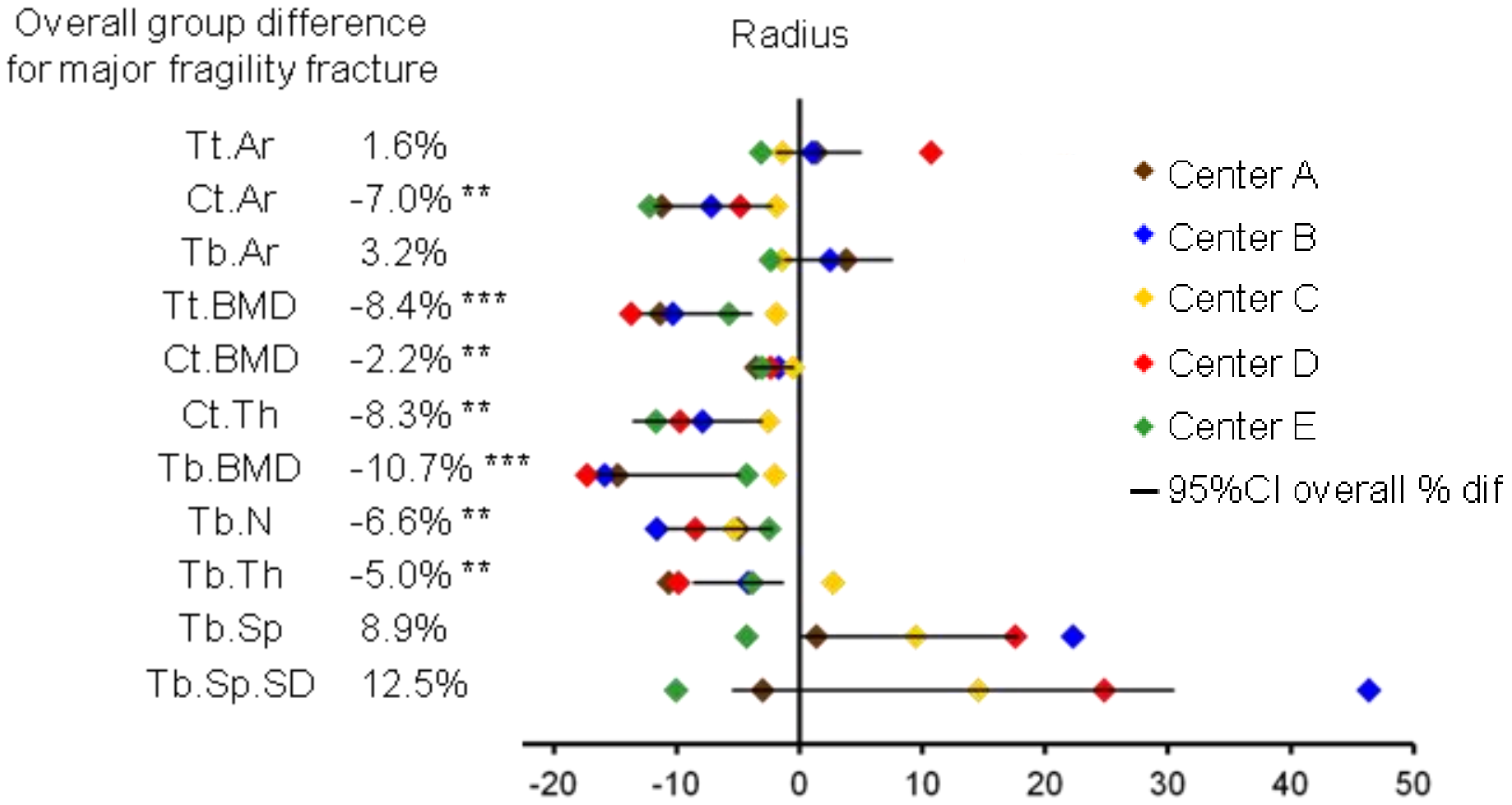
Overall and Within Center % Difference Between Major Fragility fx (n=349) and no fx



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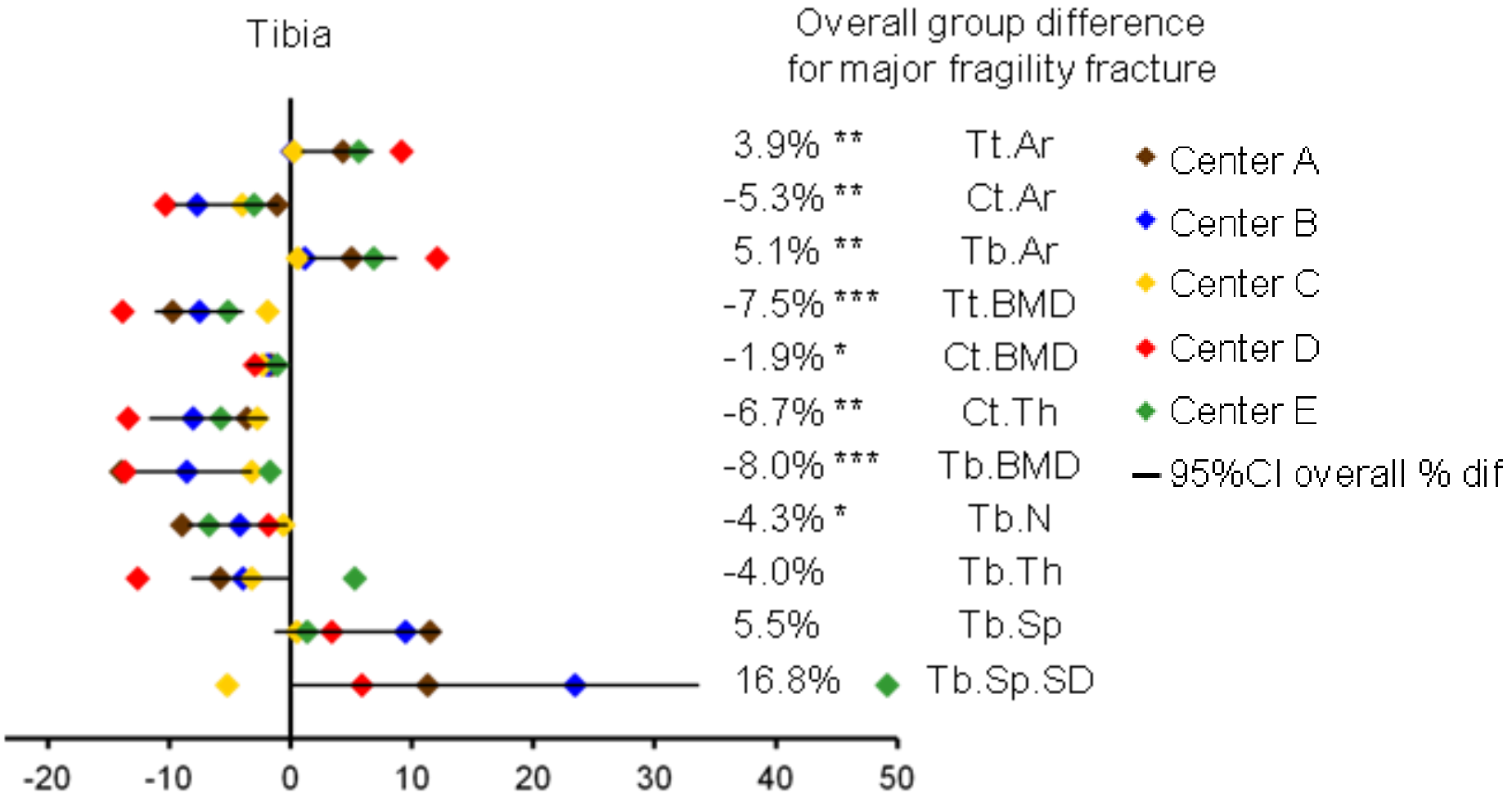

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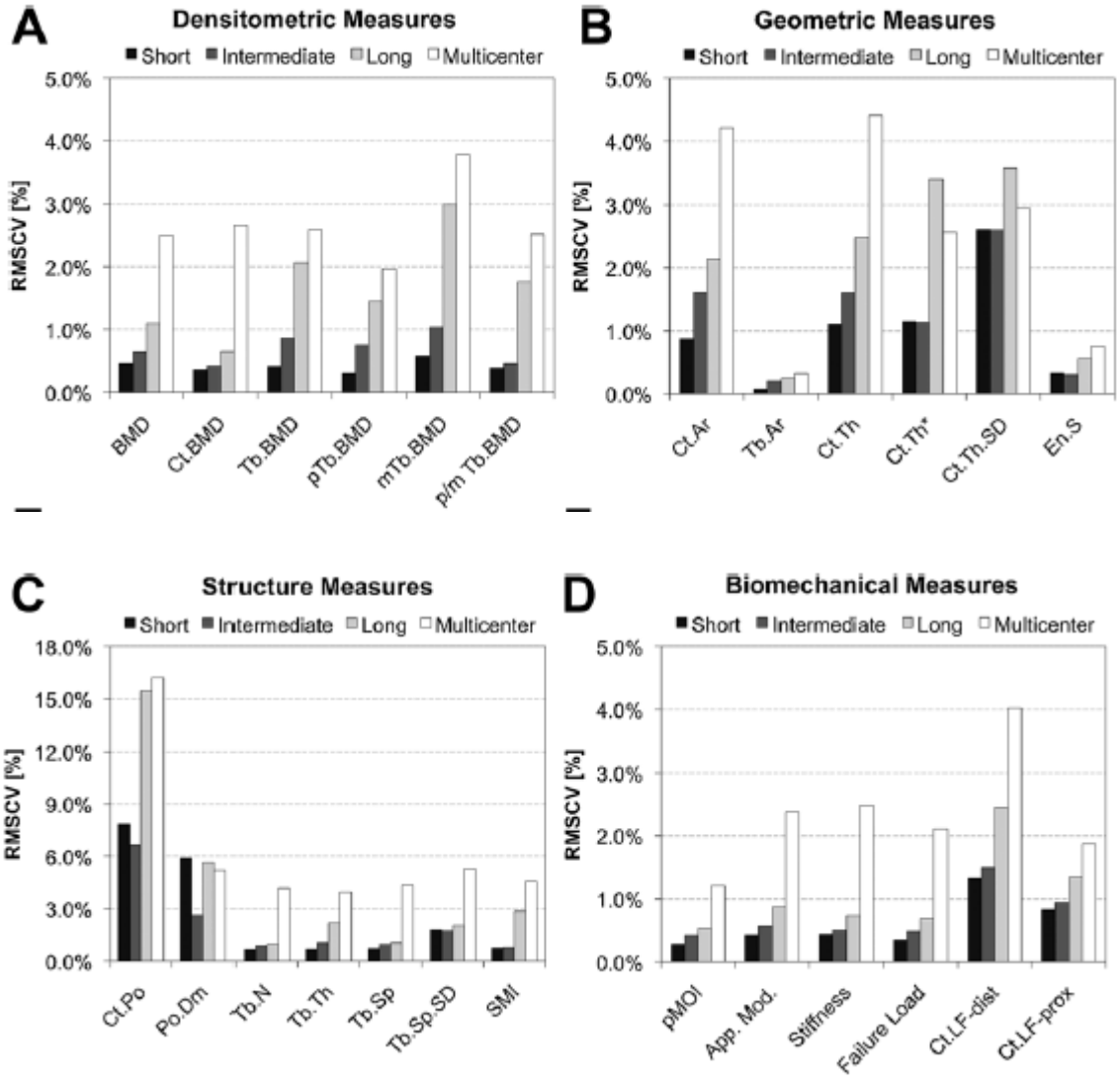
Multicenter Precision of HRpQCT

14 human embedded cadaveric radii; 9 centers; short- (< 72 hrs), intermediate- (3-5 mths), long-term (28 mths)



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LYOS Osteoporosis - Bone Metastasis - Lyon

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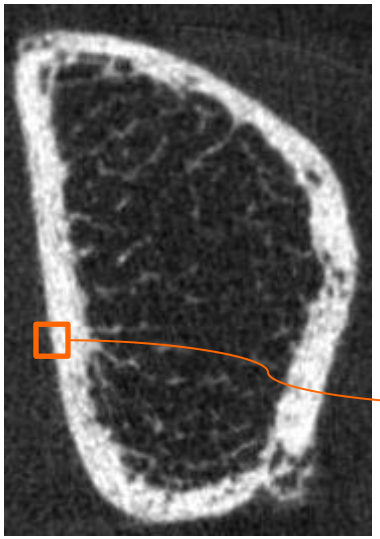
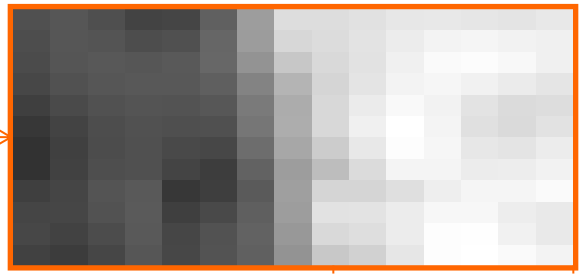
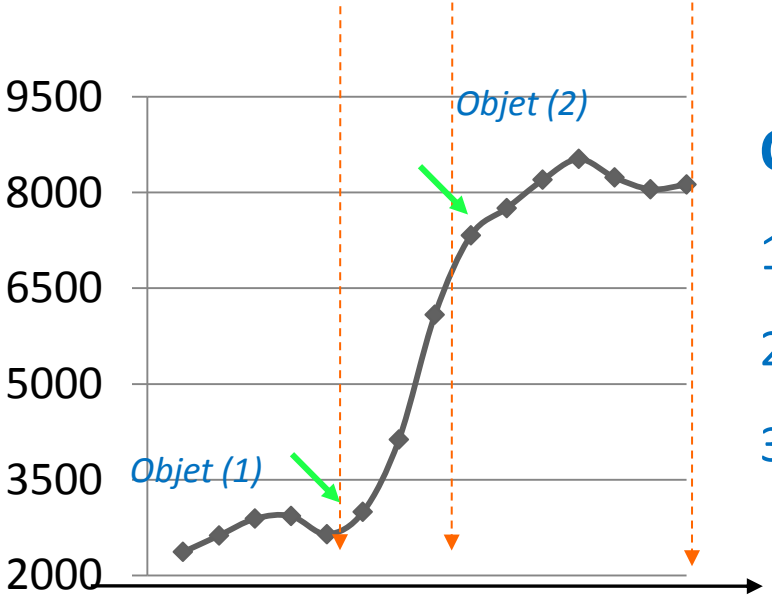
Burghardt A, et al. J Bone Miner Res 2013

Analyse de l'os cortical par Strax 1.0



Définir le contour périosté





Contour = courbe en "S"

1- Plateau relatif (objet 1)

2- Augmentation rapide (bord)

3- Plateau relatif (objet 2)

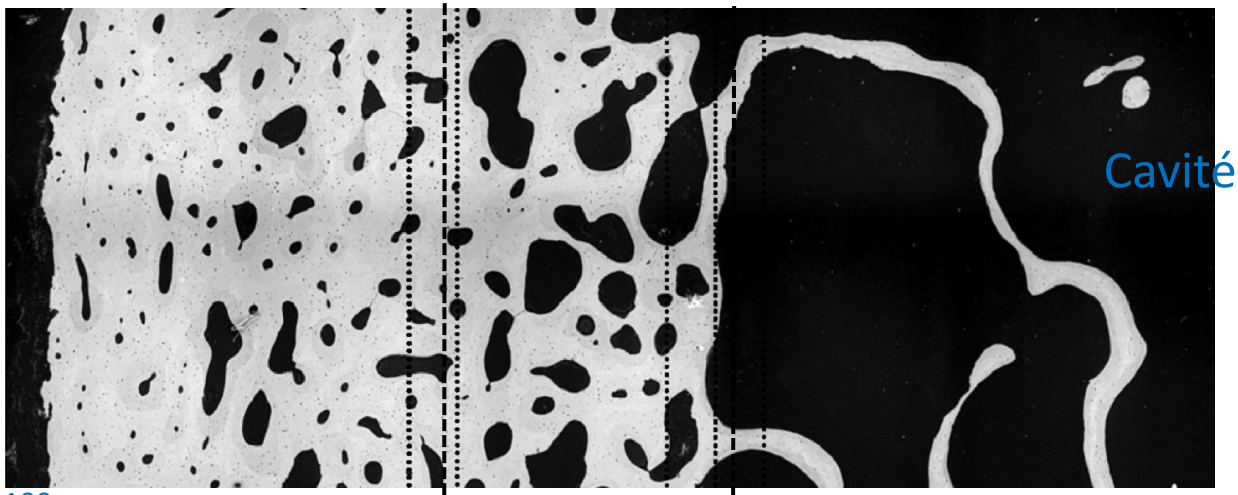
Courtesy of R. Zebaze. Bone 2013.

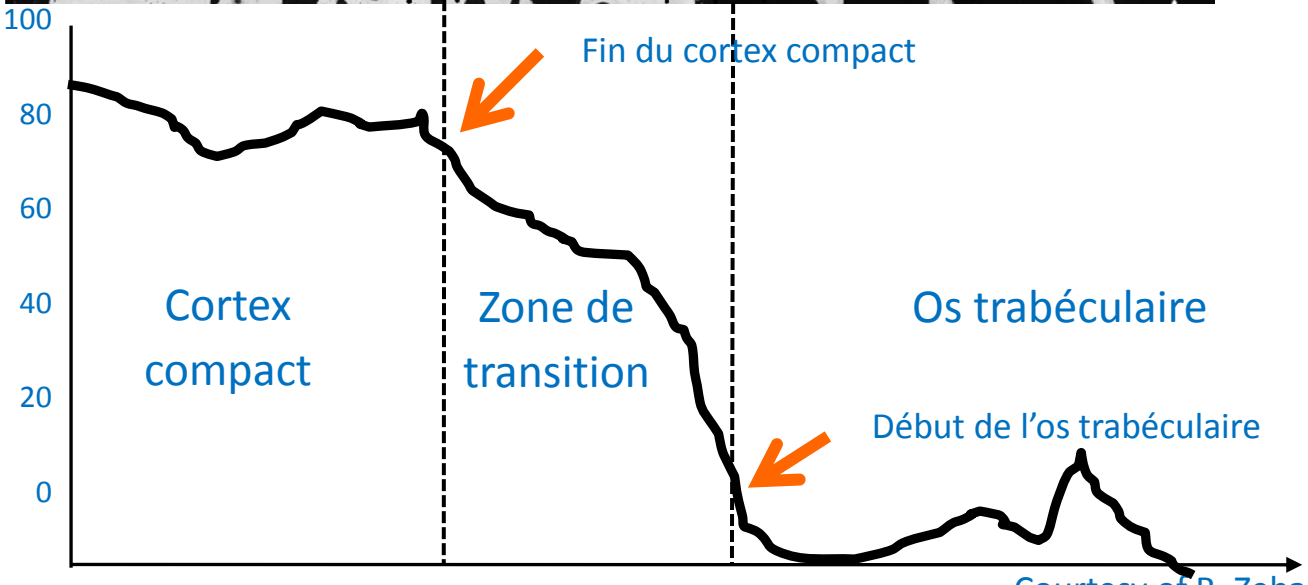
Analyse de l’os cortical par Strax 1.0

Définir le contour endosté

Périoste

Cavité médullaire





Courtesy of R. Zebaze. Bone 2013.

Analyse de l'os cortical par Strax 1.0

Mesure de la porosité corticale

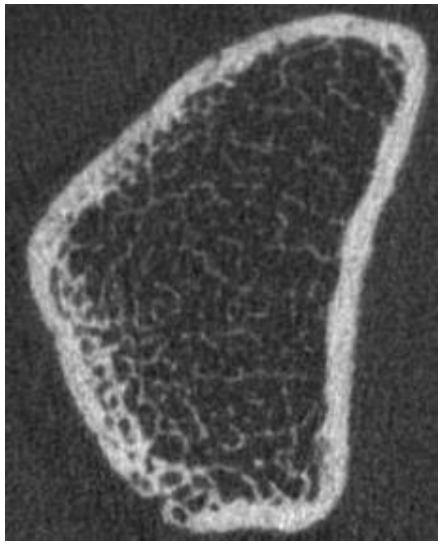
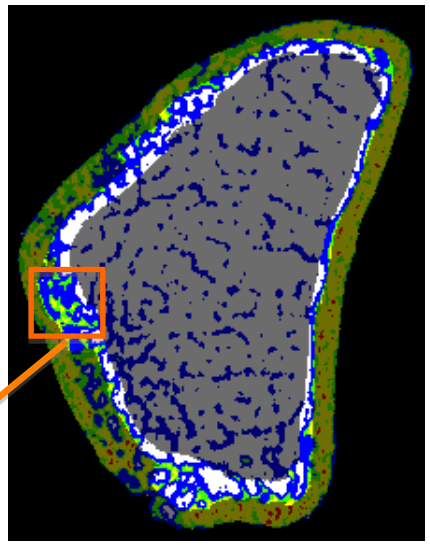


Image d'origine



Os segmenté en 3 compartiments

CMO
de chaque voxel

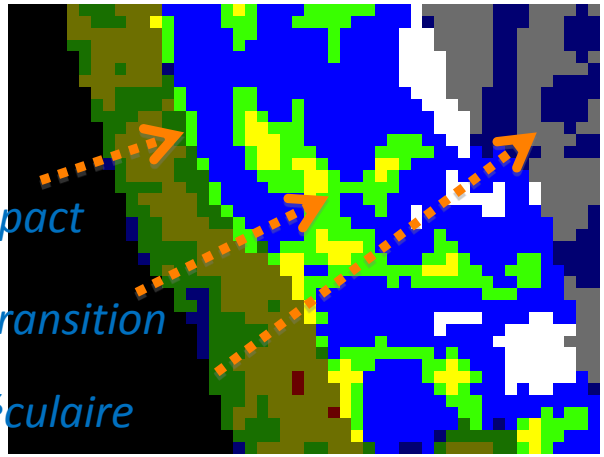
100%

> 70%

50- 70%

0-50%

0%



Cortex compact

Zone de transition

Os trabéculaire

Le volume de "vide" de chaque voxel est mesuré

Adapté de Thuy et al. Bone 2013.

Première Fx incidente par fragilité

Suivi médian [IQ] = 8,1 [0,9] ans

Site	Toutes Fx
Vertèbres	32[a]
Poignet	25
Hanche	12
Extr sup humerus	7
Cheville	12
Autres sites [b]	23
Tous sites	**111**

[a] Fractures vertébrales cliniques et morphométriques

[b] Excepté crâne, doigts, orteils

Boutroy S, et al. ASBMR 2015

Caractéristiques initiales

	Femmes Fx- N=478	Femmes Fx+ N=111
Age (ans)	67,5 ± 0,4	70,8 ± 0,9 ***
Poids (kg)	62,3 ± 0,5	62,2 ± 1,2
Taille (cm)	158,3 ± 0,3	158,7 ± 0,6
Age ménopause (ans)	50,4 ± 0,2	51,1 ± 0,4
Fx prévalentes (n, %)	85 (18)	37 (33) ***
Tabagisme actuel (n, %)	25 (5)	12 (11) *
Traitements* (n, %)	138 (29)	39 (35)
T-score rachis lombaire	-0,9 ± 0,1	-1,3 ± 0,1 **
T-score hanche totale	-0,8 ± 0,1	-1,2 ± 0,1 ***

Moyenne ± SEM sauf autre indication

* THS, Bisphosphonates, Ranélate de strontium, SERM, Tibolone, Antiaromatases, Corticoides

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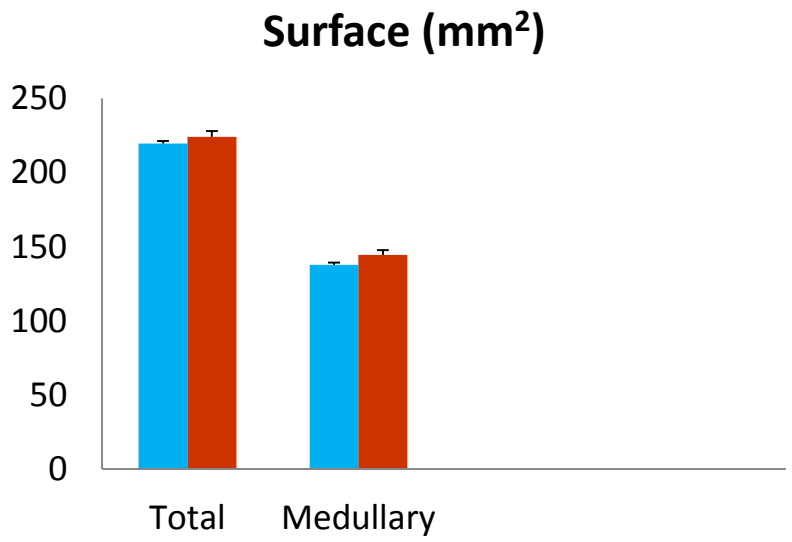
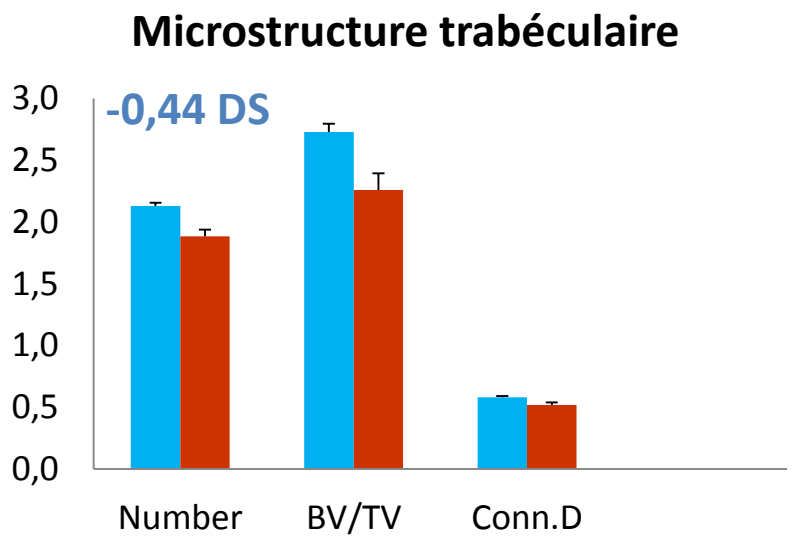
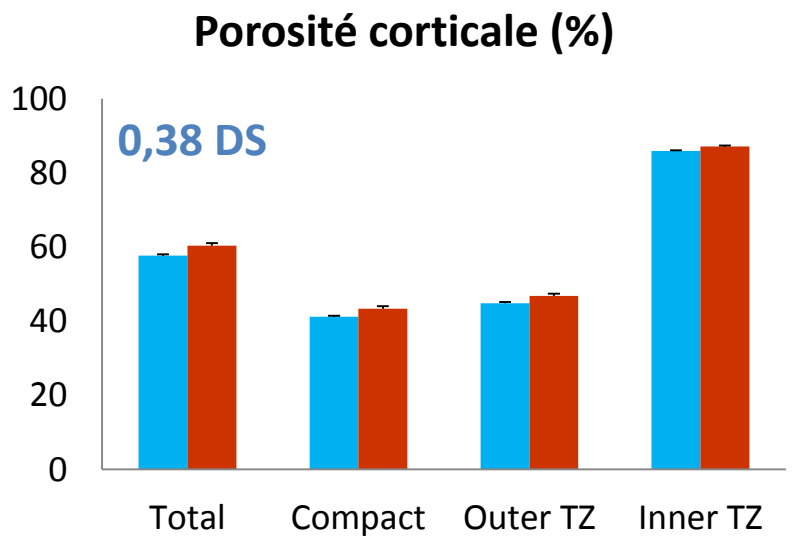
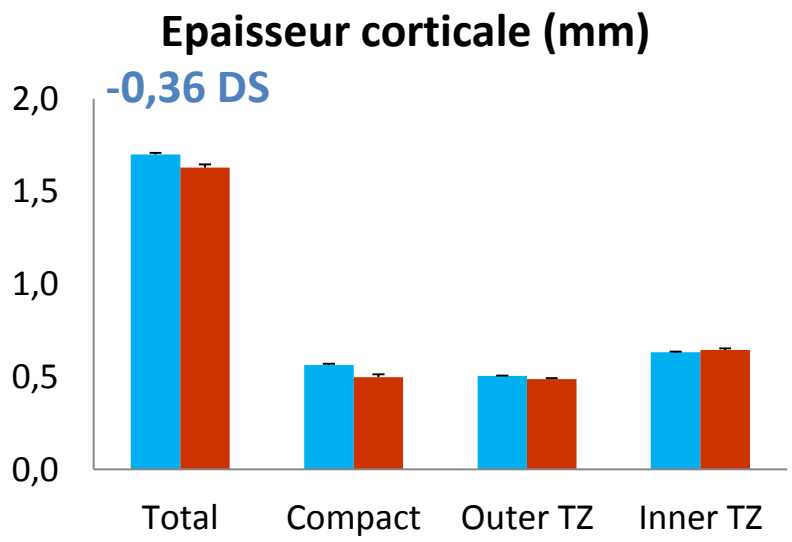
Microarchitecture osseuse









Moyenne ± SEM

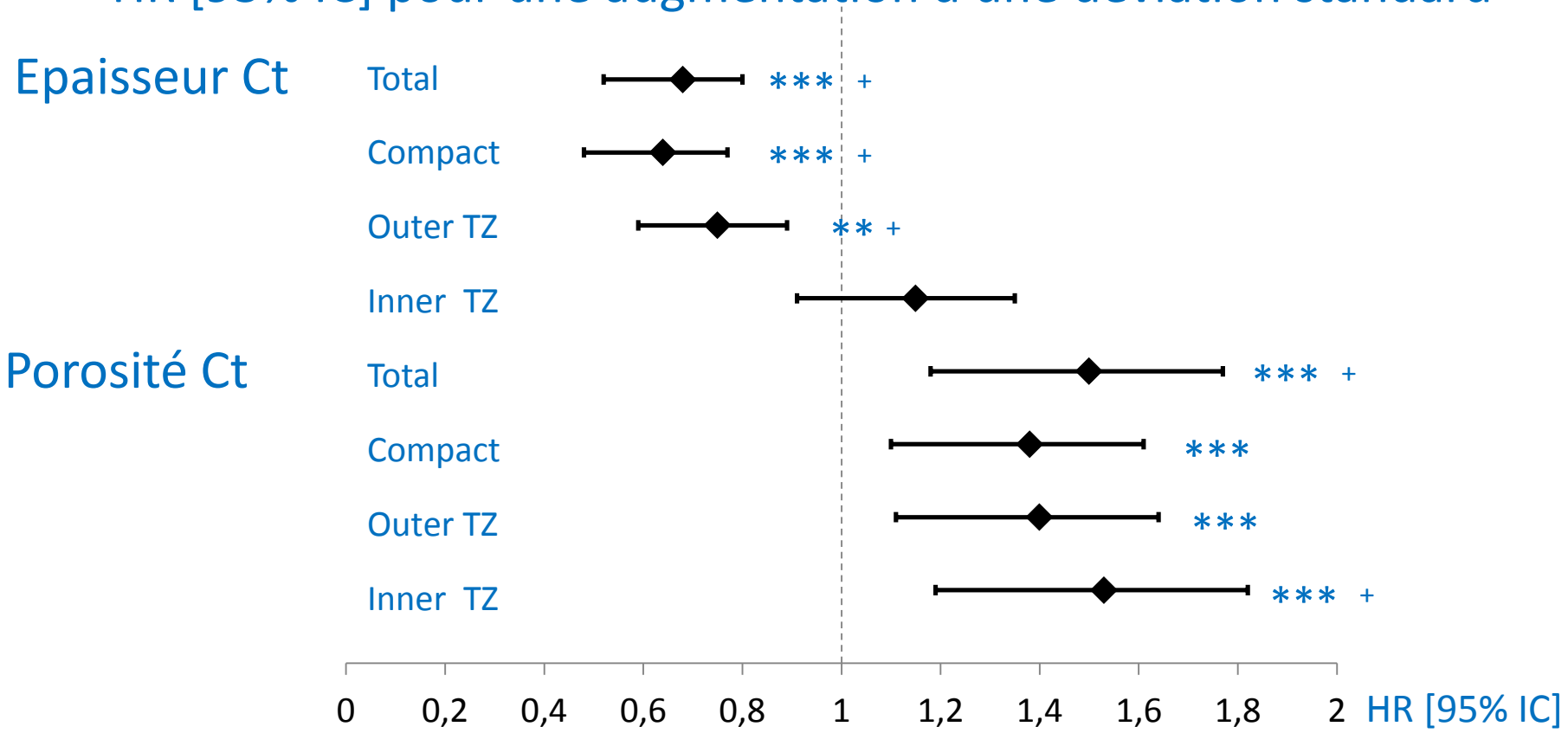
*** p ≤ 0,001, ** p ≤ 0,01, * p ≤ 0,05

Fracture

Non Fracture

Prédiction des fractures

HR [95% IC] pour une augmentation d'une déviation standard



***p < 0,001, ** < 0,01 avant ajustement

+p< 0,05 ajusté pour âge, tabac, Fx prévalentes

=> La porosité corticale prédit les fractures indépendamment de la DMO à la hanche (1,28 [1,03-1,59] par SD ; p = 0,03)

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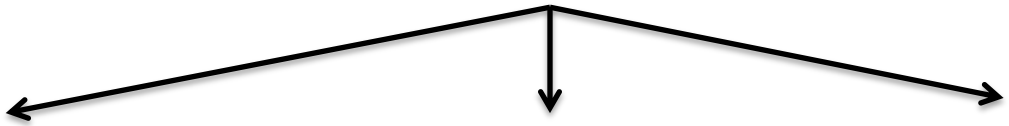
Classification

N = 589 femmes suivies pendant 8,1 [0,9] ans, (111 Fx, 18,8%)



77 (13%) ostéoporotiques

295 (50%) ostéopéniques

216 (37%) normal DMO

n = 511

Fx = 30 (39%) | 49 (17%) | 32 (15%)

27%

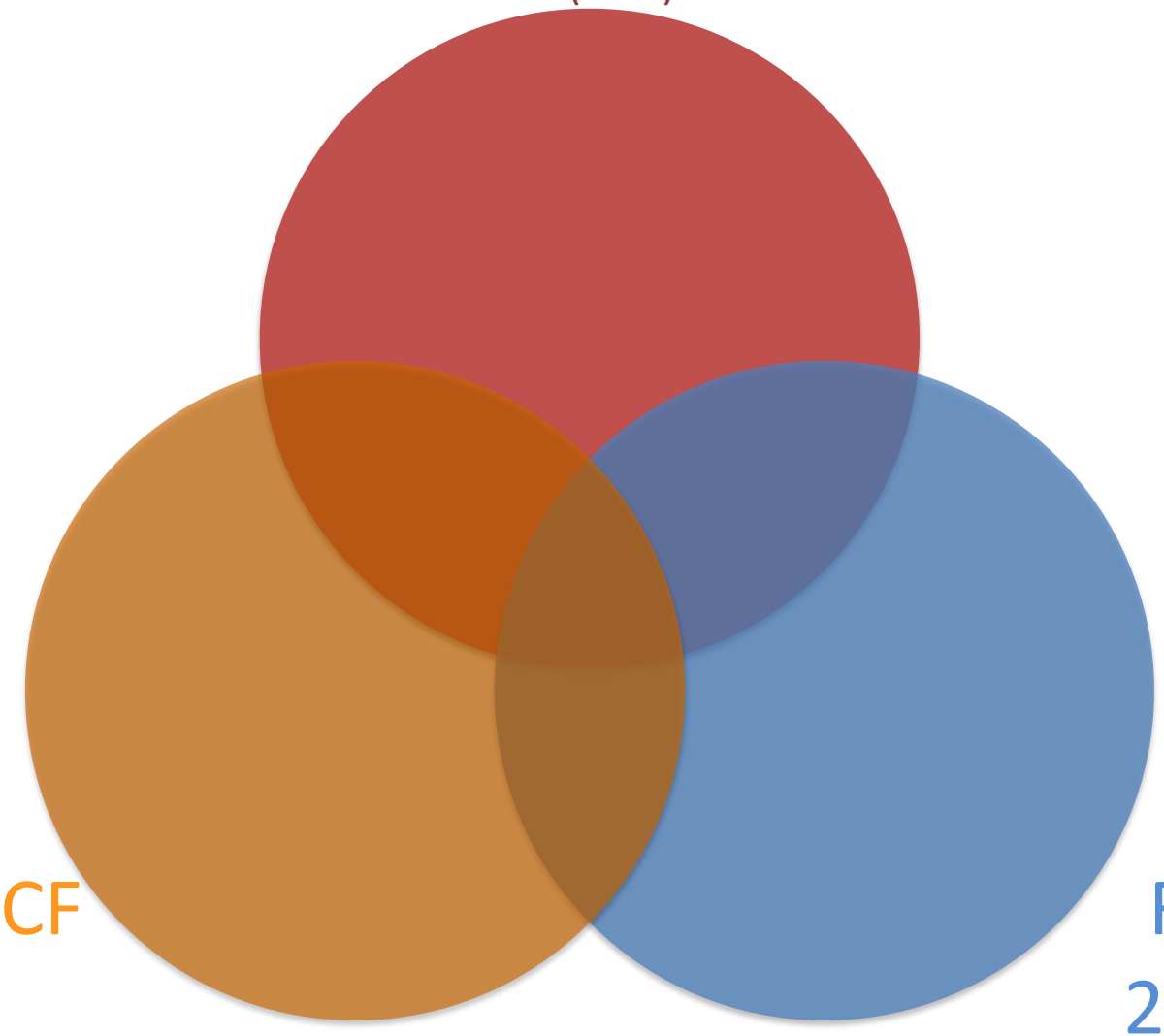
73% (16% non ostéoporotiques)

Boutroy S, et al. ASBMR 2015

Proportion de sujets détectés

111 Fractures

53 cas non identifiés (48%)



Microarchitecture and Fracture Risk Prediction in CKD

131 patients from Toronto, eGFR < 60, not on dialysis, not transplanted, followed-up for 2 years

Ability of aBMD and HRpQCT to predict incident fracture

Predictor	Fully adjusted* (n=131)	Minimally adjusted**	Unadjusted
BMD by DXA; AUC (95% Confidence Interval)			
Total Hip	0.68 (0.57 to 0.79)	0.65 (0.54 to 0.76)	0.64 (0.52 to 0.76)
Lumbar Spine	0.62 (0.50 to 0.74)	0.64 (0.52 to 0.76)	0.66 (0.57 to 0.75)
Ultradistal Radius	0.74 (0.65 to 0.83)	0.72 (0.63 to 0.81)	0.72 (0.64 to 0.79)
1/3 Radius	0.70 (0.59 to 0.81)	0.73 (0.63 to 0.83)	0.69 (0.57 to 0.81)
HRpQCT at Radius; AUC (95% Confidence Interval)			
Volumetric BMD	0.70 (0.57 to 0.83)	0.65 (0.53 to 0.77)	0.60 (0.47 to 0.73)
Cortical Area	0.73 (0.60 to 0.86)	0.68 (0.56 to 0.80)	0.65 (0.54 to 0.76)
Trabecular Area	0.65 (0.52 to 0.78)	0.66 (0.54 to 0.78)	0.61 (0.49 to 0.73)
Cortical Density	0.72 (0.59 to 0.84)	0.68 (0.56 to 0.79)	0.65 (0.53 to 0.77)
Cortical Thickness	0.72 (0.59 to 0.84)	0.67 (0.55 to 0.79)	0.64 (0.46 to 0.82)
Trabecular Density	0.62 (0.47 to 0.77)	0.60 (0.48 to 0.76)	0.61 (0.49 to 0.73)
Trabecular Thickness	0.59 (0.47 to 0.71)	0.56 (0.45 to 0.67)	0.57 (0.45 to 0.69)
Trabecular Separation	0.61 (0.48 to 0.74)	0.59 (0.47 to 0.71)	0.61 (0.49 to 0.73)

*Fully adjusted model included: serum 25-hydroxy-vitamin D, current alcohol use, falls in past year, self reported fracture after 40 and prevalent morphometric spine fracture, in addition to weight and CKD-EPI formula.

**Minimally adjusted model included: eGFR by CKD-EPI and weight.

AUC = area under the receiver operating curve.

West SL, JBMR 2015

Perspective

Avec l'imagerie, Se et Sp ne seront jamais > 65-70% en population générale

Place de l'âge dans un dépistage de masse

La place des nouvelles imageries est dans les populations spécifiques