REFERENCE GRAPHS OF AGE-RELATED CHANGES IN BONE MASS, VOLUMETRIC DENSITY, DESIGN AND STRENGTH AND OF MUSCLE-BONE INTERACTIONS IN NORMAL MEN AND WOMEN

S. Feldman*, R.F. Capozza*, G.R. Cointry*, S.E. Ferretti*, P.S. Reina*, B. Homse*, M. Zapata*, J.L. Mansur, J.L. Ferretti. ***Center of P-Ca Metabolism Studies (CEMFoC), Natl Univ of Rosario, Argentina.***

SKELETAL SITES SCANNED

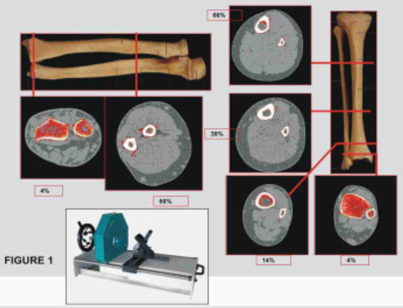

FIGURE 1

GENERAL BACKGROUND AND AIMS OF THE STUDY

The pQCT technology provides a useful set of indicators of bone "mass" (BMC, cortical area, trabecular vBMD), bone material "quality" (cortical vBMD, either crude, vCtD or corrected for the partial volume effect, Rho-vCtD, known to vary linearly with the intrinsic stiffness or elastic modulus of the tissue), bone design (diaphyseal cross-sectional moments of inertia, CSMIs) and bone strength (calculated Bone Strength Indices or Stress-Strength Indices, BSI, SSI), and of muscle strength (muscle cross-sectional area, mCSA) (**Fig 1**).

Analysis of the behavior of these indicators offers an interesting diagnostic tool for osteopenias and osteoporoses, beyond the scope of standard DXA determinations.

Regrettably, no reference charts are available of those indicators as determiend in healthy individuals for comparative diagnosis.

In order to overcome this inconvenience, we have performed pQCT scans of forearms and legs (6 different sites; **Fig 2**) of a number of normal, unfractured men (n = 60; age 15-77 yr), preMP women (n = 80; age 18-54) and post-MP women (n = 120; age 44-80).

The collected information was then analyzed aiming to describe the variations and interrelationships of the above referred indicators.

RESULTS

Three different patterns of variation of the studied indicators were shown:

1. Bone "mass" indicators were significantly higher in males than females and decayed slightly after MP (**Fig 3-5**).
2. Bone material "quality" (as assessed by vCtD or Rho-vCtD) was significantly higher in pre-MP women than men and decayed dramatically after MP (**Fig 6**).
3. Bone design was better in men than women but did not decay after MP (**Fig 7**).

The calculated BSI and SSI (all correlative to the product *CSMI*vCtD*, thus more influenced by the large allometric variance of the CSMI's than by the relatively much smaller physiological changes in vCtD) varied similarly to bone mass or design indicators (**Fig 8**).

Muscle mass (allometrically adjusted to bone size) was higher in men than women and tended nonsignificantly to decay after MP (**Fig 9**).

Bone mass, design and strength indicators (not so the vCtD) were linearly correlated with mCSA in all 3 groups, with parallel slopes for men and pre-MP women and lower slopes for post-MP women (**Fig 10-14**).

The SD-scoring of the relationships between bone mass, design or strength indicators and the mCSA for men and pre-MP women allowed calculation of individual Z-scores of every relationship for any kind of individuals, including the studied post-MP women (**Fig 6**).

The Z-scores for the relationships between bone mass or strength (not CSMIs or vCtD) and mCSA correlated negatively with years since MP (YSMP; **Fig 10, 12, 14**).

INTERPRETATION

Results show that, despite that post-MP women loose significant amounts of bone mass after MP, they would tend conveniently to maintain the diaphyseal design and strength.

From a practical point of view, our findings point out that

1. the SD-scored charts of the correlations between the different bone indicators, and of these with YSMP, provided normal references suitable for evaluation of the two true determinants of "bone quality", namely, bone material quality and design, and
2. the reference charts of the bone-muscle relationships allowed a non-invasive distinction between "disuse" and "systemic" osteopenias (with normal or reduced bone-muscle Z-scores, respectively) requiring substantially different treatments.

BONE MASS INDICATORS – I. TOTAL BMC

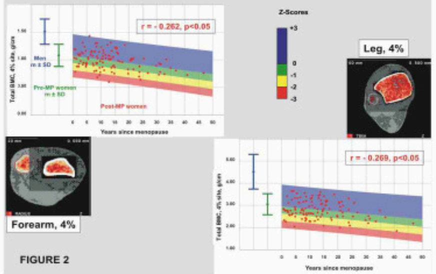

FIGURE 2

BONE MASS INDICATORS – II. TRABECULAR vBMD

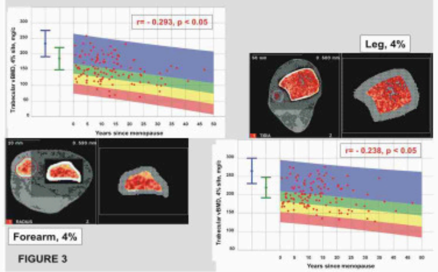

FIGURE 3

BONE MASS INDICATORS – III. CORTICAL AREA

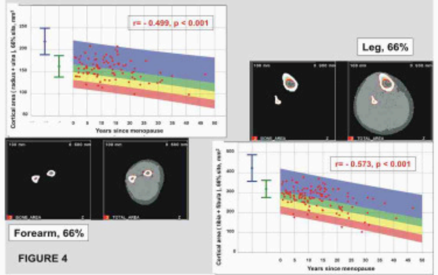

FIGURE 4

BONE MATERIAL "QUALITY" CORTICAL vCtD, crude or corrected (Rho-vCtD)

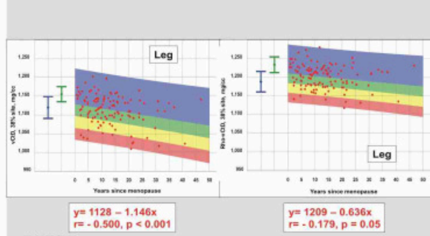

FIGURE 5

BONE DESIGN INDICATORS
Diaphyseal cross-sectional polar moment of inertia, (pCSMI)

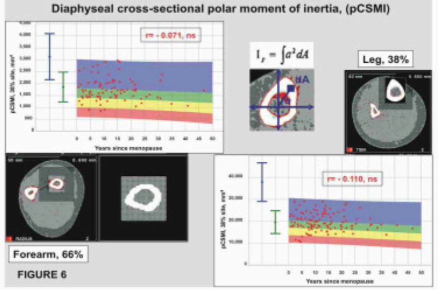

FIGURE 6

BONE STRENGTH INDICATORS – SSI

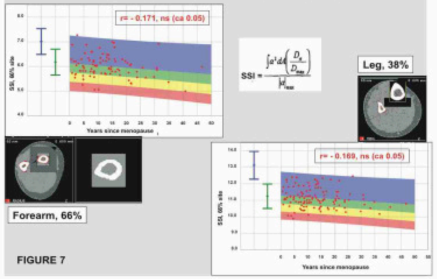

FIGURE 7

MUSCLE STRENGTH INDICATORS – Muscle CSA
(Anthropometrically adjusted to periosteal PM)

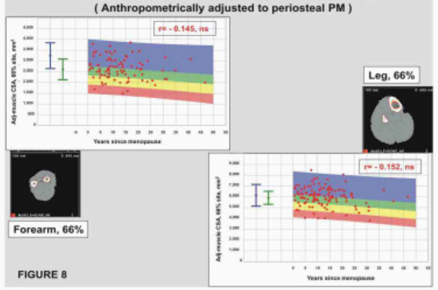

FIGURE 8

MUSCLE – BONE RELATIONSHIPS
I - IMPACT ON CORTICAL AREA (Tibia + fibula, 66%)

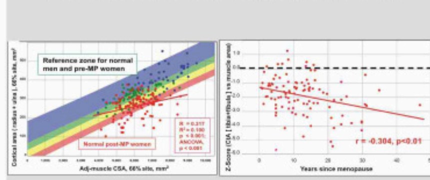

FIGURE 9

MUSCLE – BONE RELATIONSHIPS
II - IMPACT ON CORTICAL DESIGN (Tibia, 38%)

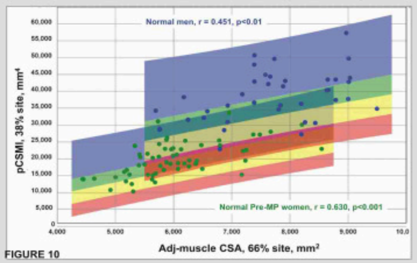

FIGURE 10

MUSCLE – BONE RELATIONSHIPS
II - IMPACT ON CORTICAL DESIGN (Tibia, 38%)

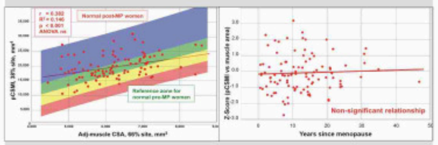

FIGURE 11

MUSCLE – BONE RELATIONSHIPS
III - IMPACT ON DIAPHYSEAL STRENGTH (Tibia, 38%)

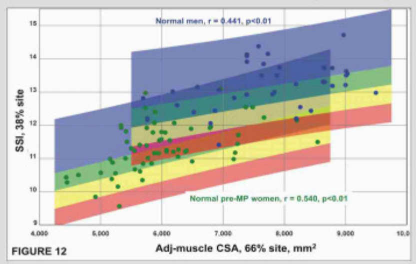

FIGURE 12

MUSCLE – BONE RELATIONSHIPS
III - IMPACT ON DIAPHYSEAL STRENGTH (Tibia, 38%)

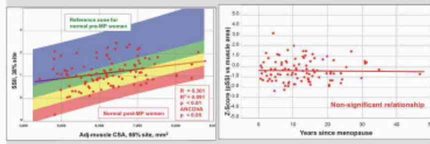

FIGURE 13