

Table 4. Mean Values and Standard Deviations for Parameter C

Item	\bar{C}_D	SD	\bar{C}_{VD}	SD	\bar{C}_{VVD}	SD
Sample	70.2	19.2	105.9	23.6	125.0	18.7
Group A	69.3	12.0	95.1	24.8	114.6	7.5
Group B	68.6	26.8	106.5	25.1	119.0	12.7

Abbreviations C, coarseness; D, distal; SD, standard deviation; VD, very distal; VVD, very-very distal.

pends both on the precision of the xy scanner used to derive the photometric values and also on the position of the forearm during the x-ray examination. In fact, if the forearm is rotated on its own longitudinal axis, different projections of the same bone can be radiographed. Thus, when the x-ray is analyzed, the data input to the system can vary, and different results can be obtained. On the other hand, positions of the forearm that involve an inclination of the longitudinal axis on the x-ray field are compensated by registering the x-ray before digitizing it so that the measuring sites can remain as lines perpendicular to the longitudinal axis of the bone. However, in this way it is still possible to have variations in the measures because of the subjective localization of the reference line on the subchondral surface made by the user. These two types of errors, which depend on the torsion of the forearm or on the user interaction, are evaluated either by repeating the analysis of the same x-ray with a different operator or by analyzing x-rays of the same patient taken at different times. This type of statistical investigation has still not been performed and, consequently, we can only report the measuring error introduced by the xy scanner: the measuring precision is $\pm 0.5 \times 10^{-3}$ Almm and it is obtained by analyzing the data reported in Table 1.

Table 3 shows that the value of C increases from the distal site to the VVD site in all 25 cases. Assuming that C depends on the trabecular content of the radiographed bone structure, the measurements obtained using our method are in agreement with those found by Nilas,¹⁵ who calculated the relative content of the trabecular bone from 13 necropsies.

Applying the test of significance to the difference between the mean values for groups A and B, in Table 4 we obtain the values $t = 0.052$ in site D, $t = 0.951$ in the VD site and $t = 0.665$ in

the VVD site. These values are considerably below Student's t index for 13 degrees of freedom, which is equivalent to $t = 2.160$ for a level of significance of 95%. For this reason we cannot yet affirm that the difference between the means is significant, despite the fact that the results obtained indicate that the most suitable site for the analyses proposed is the VD site.

A diminution of the number and an increase in the density of the remaining trabeculae can be noted in the radiograms of osteoporotic subjects. The value given to C, which depends mainly on the trabecular component, makes it possible to quantify the information gathered from the radiograms, even though the results of the method followed to obtain C show a certain degree of indetermination.

In fact, to derive C, a filter is applied to the acquired signal and the power spectrum of the filtered signal is measured. Because there is, in general, a spatial frequency interval in which the power spectrum depends exclusively on the trabecular pattern, the filtering operation can introduce an error that cannot be estimated with precision without making a further comparative study with istomorphometric measurements.

The postmenopausal osteoporotic process is characterized both by a diminution in the total bone mineral content and by a variation in the percentage of the trabecular content. The value of C by itself is thus not sufficient to quantify the mineral loss. The C/T ratio is far more suitable for this purpose because it also takes the total bone content into account.

The value of T depends both on the cortical and on the trabecular structure. However, T is also dependent on the nonbone components. The contribution given by these to the attenuation of the x-ray imaging has in fact only been eliminated to a certain extent, using a function obtained by linear interpolation between two points on the graph of a scanning line of the image. Consequently, an estimate of the percentage of the trabecular component from the C/T ratio is affected by a measuring inaccuracy. Nevertheless, although it is not equivalent to the istomorphometric measurement of the percentage of trabecular bone content, C/T supplies a useful estimate for diagnostic purposes.

The graph in Fig 6 shows the mean values of