Paradoxical Bilateral Asymmetry in Bone Size and Bone Mass in the Hand

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ABSTRACT Among 227 chronic renal disease patients, micrometer caliper radiogrammetric measurements of the second metacarpal at midshaft showed the right metacarpal to be larger (with greater bone area) and with a greater cortical area than the left second metacarpal, both in 208 right-handed individuals and in 19 left-handed individuals. This direction of asymmetry was individually characteristic of the majority of individuals, whether right-handed, left-handed or ambidextrous.

In the course of studies on bone loss in chronic renal disease patients (CRD) using micrometer caliper measurements on postero-anterior hand radiographs, we became concerned with bilateral (left-right) asymmetry for two practical reasons. The first source of concern stemmed from the fact that approximately 10% of the patients were left-handed, as judged from hand-preference records, whereas the standards used for comparison were left-handed standards (cf. Garn, '70). The second source of concern arose from the location of indwelling fistulas in dialyzed patients and the possibility that the location of the fistulas as well as handedness might both have to be taken into account. Accordingly, we explored bilateral hand asymmetry in 227 patients and found evidence for a small but statistically-significant left-right difference in bone area, cortical area (bone mass) and percent cortical area.

Prime bone measurements on these patients (most of whom were adults) included the total subperiosteal diameter (T), and medullary cavity width (M) as measured on the second metacarpal at midshaft, using a standardized tube-to-film distance throughout (Garn, '70; Garn et al., '71). Total area (TA), cortical area (CA) and percent cortical area (PCA) were then computer calculated on an individual basis for each patient, for each side separately. The left-right differences (d) were also individually computer calculated, and then the d values were tested for significance by tests appropriate for matched pairs (Dixon and Massey, '69). Since all comparisons were intra-individual though inter-side, the 118 males and 117 females were not separately tabulated.

As shown in table 1, among 208 right-handed patients, bone area (TA) proved significantly larger in the right side than on the left ($t = 5.3$). In similar fashion, cortical area (CA) also proved larger in the "dominant" (right) hand in these right-handed patients ($t = 2.5$). In contrast, percent cortical area (PCA) was higher on the left or smaller side, in these right-dominant CRD patients of both sexes ($t = 3.1$). On an individual basis, and excluding cases where the measurements were identical on both sides, 129 of the right-handed patients had greater bone areas on the right side and 64 on the left; 113 evidenced greater cortical area on the right side and 82 on the left.

Turning to the 19 left-handed ("left-dominant") patients, the same trends were also found (table 1). The left-handed patients had larger bone areas on the *right* side, larger cortical areas or bone masses on the *right* side and, like the right dominant patients, larger percent cortical areas (PCA) on the *left* side. A smaller group of five ambidextrous patients not originally considered also displayed a larger bone

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TABLE 1

Bilateral (left-right) hand asymmetry in 227 renal patients

Metacarpal measurement	Right	Left	Difference [1]		
			Mean	S.E.	t [2]
	208 right-handed patients				
Total area (mm^2)	61.7	59.5	2.3	0.4	5.3
Cortical area (mm^2)	48.6	47.6	1.0	0.4	2.5
Percent cortical area	79.4	80.5	−1.2	0.4	3.1
	19 left-handed patients				
Total area (mm^2)	60.2	59.3	0.9	1.2	0.7
Cortical area (mm^2)	47.0	46.4	0.6	1.3	0.4
Percent cortical area	78.9	79.3	−0.4	1.4	0.3

[1] Computer-calculated on an individual basis prior to rounding-off.
[2] Calculated as the difference between paired values.

area and a larger bone mass on the right side. Paradoxically, therefore, hand dominance or "handedness" does not seem to be a major factor in the tendency toward larger bone areas and bone masses on the right side.

Exact literature parallels are not available, whether in radiogrammetric comparisons of the forearm (Buskirk et al., '56) or by direct-photon absorptiometry (cf. Watson, '73). In the latter study, the dominant side proved to have larger bone widths and bone masses, but handedness was not specifically partitioned. We also have available direct-photon absorptiometric measurements of the forearm of 184 patients, but with rather inconclusive results (insofar as statistical significance is concerned) and with positive but low-order correlations between the magnitudes of bilateral asymmetry in the hand and in the forearm.

Now these left-right differences in cross-sectional area (TA), cortical mass (CA) and percent of compact bone (PCA) are all small, and for many purposes may well be ignored. By every measure we have employed, including direct-photon absorptiometry, bone loss is considerable in these chronic renal disease patients, and it makes little difference whether the "scans" and the radiographs are made on the right side or the left. However, with the present evidence for a small but systematic difference between the sides, it makes sense to measure the left side uniformly if left-side reference norms are employed.

Still it is intriguing that the right side tends to be the larger side, even in patients whose preferred hand is the left (i.e., "left dominance"). This may be a peculiarity of the patient group studied, including transplant and dialysis patients, and it may still be an accident of sampling, and it may reflect the fact that left-dominant individuals actually employ their right hands to a greater extent. However, in a much earlier and hitherto unpublished study, we found that left-handed normal subjects were not dimensionally smaller in the left second metacarpal, and, therefore, developed norms and standards based on the left hand, throughout.

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