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RELATIONS BETWEEN FEMUR DENSITY AND STRONTIUM-85 UPTAKE IN BIPEDAL RATS

By

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The rate of entry of isotopes of calcium and strontium into bone is referred to as the accretion rate and is generally held to be a good parameter of bone formation rate in animals and humans (*Bauer* 1954, *Wendeberg* 1961, *Dymling* 1964). We have found (*Nilsson & Saville* 1967) that when rats sustain a fracture of the tibia, the ipsilateral femur does not grow as fast as the contralateral femur. The twenty-four hour uptake of strontium, measured as per cent of dose per unit ash in the smaller femur, on the fractured side is greater than that in the larger femur on the uninjured side but the same as that in a femur of the same volume and density from a smaller rat. This suggests that bone density rather than bone formation governs the uptake of radiostrontium under these conditions. To test this point further, we have altered the relations between body weight and bone density by raising bipedal rats, which have larger, denser, and stronger femora than normal rats of the same weight (*Saville & Smith* 1966, *Smith & Saville* 1966).

MATERIAL AND METHODS

In thirty-four male Sprague Dawley rats of the Charles River strain bipedalism was accomplished shortly after birth according to the method of *Saville & Smith* (1966). The animals were raised after weaning on a commercial rat diet. They were killed at pre-determined weights between 50 and 500 g. Fifty-six control rats of the same sex and strain, fed the same diet, were killed at approximately the same weight range. Twenty-four hours before sacrifice, each animal was injected subcutaneously with about three microcuries of strontium-85. The left femur was removed from each animal, cleaned of soft tissue, and weighed suspended from a fine copper wire in air and in water at 4° C. The volume was determined according to Archimede's Principle. The bones were ashed for forty-eight hours at 600° C, the ash was

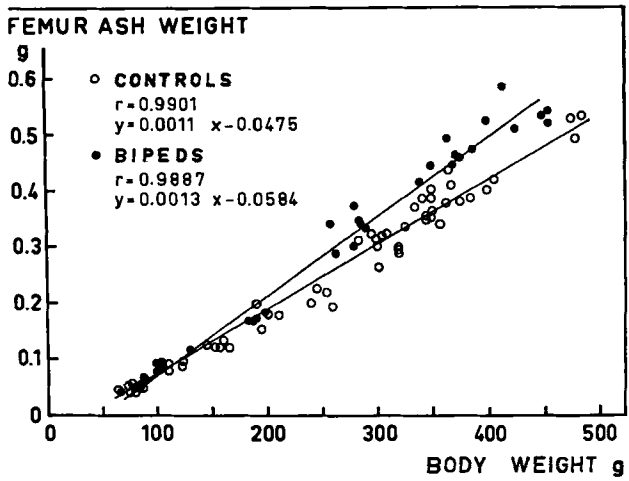

Figure 1. Femur ash weight is plotted as a function of body weight. Regressions are calculated by the method of least squares. There is a significant slope difference ($P < 0.001$).

weighed and transferred to test tubes where the radioactivity was measured in a well scintillation counter to a precision of 1 per cent. By comparing the counting rate of the samples to that of a known standard, the activity was calculated and expressed as per cent of the injected dose. Regressions were calculated by the method of least squares and were compared one with another by analysis of covariance.

RESULTS

The ash weight of the femur was a linear function of body weight both in the controls and in the bipeds but at any given body weight, the bipeds had significantly more ash ($P < 0.001$) (Figure 1). The volume of the femora also was a linear function of body weight in both groups but the bipeds had significantly greater volume at any given body weight ($P < 0.001$) (Figure 2). The density of the femora, expressed as grams of ash per cubic centimeter of bone, was a linear function of body weight in both groups, but the bipeds had significantly greater bone density than the controls ($P < 0.001$) (Figure 3). The ash weight of the femora approximated a linear function of the femur volume in both bipeds and controls and at any given femur volume the ash weight was not significantly different in the two groups of animals (Figure 4). The specific activity of Strontium-85 was a negative exponential function of bone density and at any given bone density the specific activity

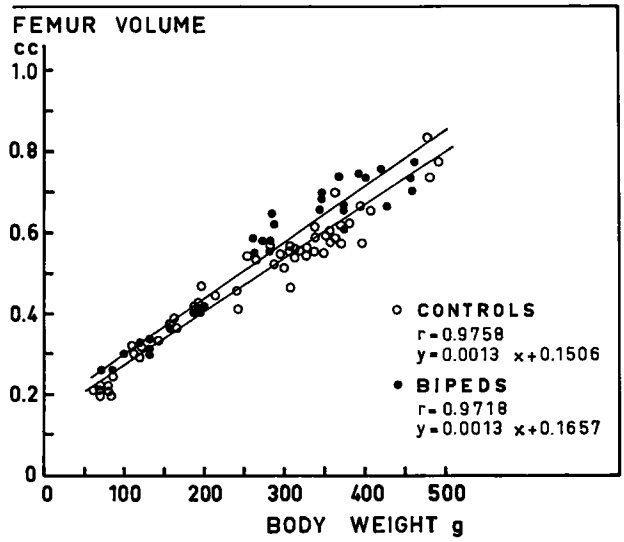

Figure 2. Femur volume is plotted as a function of body weight. Regressions are calculated by the method of least squares. There is a significant difference in adjusted means ($P < 0.001$).

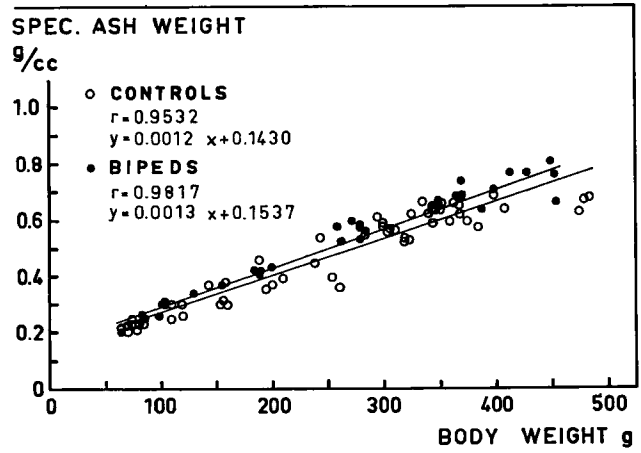

Figure 3. Ash per cc of femur is plotted as a function of body weight. Regressions are calculated by the method of least squares. Analysis of covariance shows a significant difference in adjusted means ($P < 0.001$).

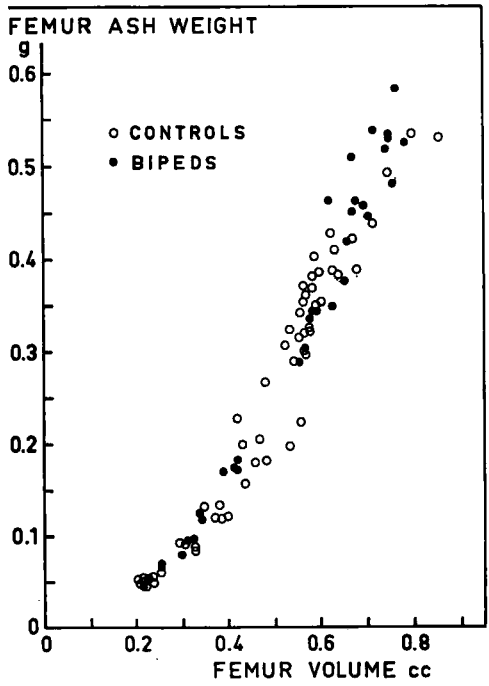

Figure 4. The ash content of the femora is plotted as a function of femur volume. At any given femur volume, there is no significant difference in ash content in the two groups.

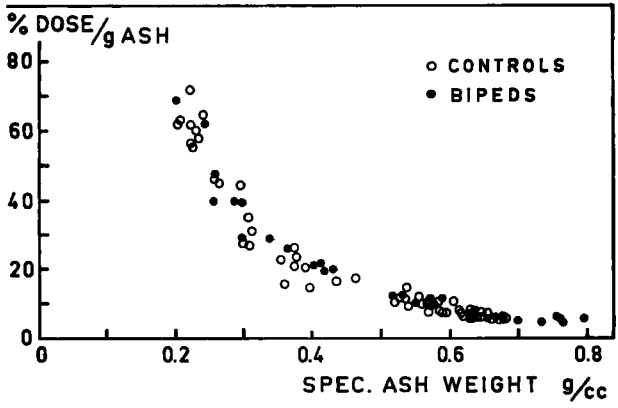

Figure 5. Specific activity of the femur is plotted as a function of femur specific ash weight. At any given specific ash weight, there is no difference in specific activity in the two groups.

was identical in both groups (Figure 5). In short, bipedal femora are larger than controls of the same weight but they have just the right amount of Strontium-85 for bones of their density.

DISCUSSION

Bipedal rats have larger, denser, and stronger femora for their body weight than do controls. We have succeeded in disturbing the relation between body weight and femur growth in these animals. The changes thus introduced, however, did not interfere with the relationship of size, density and uptake of Strontium-85. This supports our previous observation that bone density or a physical property of bone related to density is an important factor influencing the uptake of mineral tracer in the rat femur.

SUMMARY

The volume, the mineral content and the twenty-four hour uptake of Strontium-85 were measured in the femora of bipedal and quadripedal rats. The relationships of ash content to volume, and of uptake of Strontium-85 to density, were not influenced by the changes of femur growth introduced by bipedalism.

RESUME

Le volume, la teneur en minéral et l'absorption pendant 24 heures de Strontium 85 ont été mesurés en les deux femurs sur des rats bipèdes et quadripèdes. Le rapport entre la teneur en cendes et le volume, et entre l'absorption de Strontium 85 et la densité ne sont pas influencés par les modifications de la croissance du fémur introduites par le bipédalisme.

ZUSAMMENFASSUNG

Das Volumen, der Mineralgehalt und die vierunzwanzigsündige Aufnahme von Strontium-85 wurden in den Femora von zwei- und vierfüssigen Ratten gemessen. Das Verhältnis von Aschengehalt zu Volumen und von Strontium-85 Aufnahme zu Dichtigkeit wurde durch die Veränderungen des Femurwachstums, die durch zweifüssigkeit hervorgerufen worden war, nicht beinflusst.

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