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### ORIGINAL RESEARCH COMMUNICATION

Treatment of anorexia nervosa is associated with increases in bone mineral density, and recovery is a biphasic process involving both nutrition and return of menses<sup>1,2,3</sup>

Jennifer Dominguez, Linnea Goodman, Surupa Sen Gupta, Laurel Mayer, Sarah Fischer Etu, B Timothy Walsh, Jack Wang, Richard Pierson and Michelle P Warren

<sup>1</sup> From the Departments of Obstetrics and Gynecology (JD, LG, SSG, and MPW), Psychiatry (BTW), and Medicine (MPW and RP), Columbia University Medical Center, New York, NY; New York State Psychiatric Institute, New York, NY (BTW, LM, and SFE); and St Luke's—Roosevelt Hospital Center, New York, NY (RP and JW)

Background: Recovery from osteoporosis in anorexia nervosa (AN) is uncertain.

Objective: The purpose of this study was to understand the changes in bone mineral density (BMD) in women with AN and the mechanisms of recovery from osteopenia.

Design: We studied BMD and markers of bone formation and resorption, osteocalcin and N-telopeptide (NTX), in patients with AN (n = 28) who were following a behavioral weight-gain protocol.

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Results: Anorexic patients experienced significant percentage increases in BMD (4.38  $\pm$  7.48% for spine; 3.77  $\pm$  8.8% for hip; P < 0.05 for both) from admission until recovery of 90% ideal body weight, achieved over 2.2 mo. NTX concentrations were higher in patients with AN at admission than in healthy control subjects (n = 11; 69.0  $\pm$  31.09 and 48.3  $\pm$  14.38 nmol/mmol creatinine, respectively; P < 0.05) and in reference control subjects (n = 30; 69.0  $\pm$  31.09 and 37.0 $\pm$ 6.00 nmol/mmol creatinine, respectively; P < 0.05). In weight-recovered subjects with AN, osteocalcin increased (from 8.0  $\pm$  3.05 to 11.2  $\pm$  6.54 ng/mL; P < 0.05), whereas NTX remained elevated (from 69.0  $\pm$  31.09 to 66.7  $\pm$  45.5 nmol/mmol creatinine; NS). A decrease in NTX (from 70.7  $\pm$  40.84 to 45.9  $\pm$  22.72 nmol/mmol creatinine; NS) occurred only in the subgroup of subjects who regained menses with weight recovery.

Conclusions: Nutritional rehabilitation induces a powerful anabolic effect on bone. However, a fall of NTX and a shift from the dominant resorptive state, which we postulate involves full recovery, may involve a hormonal mechanism and require a return of menses. Nutritional rehabilitation appears to be critical to bone recovery and may explain the ineffectiveness of estrogen treatment alone on BMD in the cachectic state.

Key Words: Anorexia nervosa • bone mineral density • osteopenia • amenorrhea • bone markers