

LONG TERM PERFUSION LOADING OF TRABECULAR BONE CORES AND FORMATION RATE

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The purpose of this study was to determine human femur head trabecular bone core (5mm thick and 10 mm in diameter) response to mechanical loading at, 0, 650 and 1000 μe , stimuli in a culture loading chamber and loading system. The computer-controlled high-voltage piezoelectric crystal stack permits bone specimens to be precisely loaded while force and compression were simultaneously measured. Static and dynamic histomorphometry responses of the loaded bone cores were investigated.

Twenty trabecular bone cores were obtained from a human femur head of a 68-year-old male patient who had hip replacement do to coxarthrosis. The perfusion medium was Dulbecco Modified Eagle Medium (DMEM) containing: 10% fetal calf serum (FCS), 72.2mg/l Ca and 28.5mg/l P, 2 mM glutamine, 5 mM β -glycerophosphate, streptomycin and penicillin G at 50,000 U/l each, vitamin C 10 ? g/ml, 0.12g/l of NaHCO₃ and 10 mM HEPES. All bone cores and medium were maintained at 37 °C, in a controlled temperature room, and a pH of 7.2-7.3 throughout the study periods. The cores were perfused at a rate of 3.2-3.4 $\mu\text{l/hr}$ using an Ismatec pump. The medium was changed at 48-hour intervals. Three groups were randomly formed, control none loaded (N=6), loaded at 650 me (N=7) and at 1000 me (N=7). All bone cores were loaded in the loading chambers, for 300 cycles/day, at 1 Hz for 49 days. Bone cores were label on days 19, and 32 with Calcein for two hours, and on day 44 with Alizarin red for 4 hours.

There were no differences among groups for MAR detected between control (0.425 $\mu\text{m/day}$), and loaded bone cores 650 μe (0.534 $\mu\text{m/day}$) and the 1000 μe (0.486 $\mu\text{m/day}$) over the 49 day study by ANOVA, therefore results are reported as mean (SD) for all groups. The relative bone volume of the cores averaged 26.6 (9.8)% of total volume. Alizarin red label on day 44 was extensive with 79 (23)% labeled surface. Double label surface from day 34 and 44 averaged 15 (14)% and MAR averaged 0.48 (0.18) ? m/day. Only two sections

had double calcein labels (day 19 + 34). Stained sections show abundant osteoid, osteoblasts, and scattered osteoclasts indicating continued bone turnover.

We concluded that while the level of mechanical loading was not adequate to increase the rate of bone formation, all bone cores showed MAR and resorption over the 49 days study as demonstrated by the presents of both double and triple labeled trabeculae. It is also clear from the histological sections that there are active osteoblast and osteoclast at the 49th days of the study.

In addition these ex vivo bone cores demonstrate mineral apposition rates similar to those from in vivo double labeled iliac crest biopsies in 11 females (65-74) of .477 ? m/day (Recker 1988) and in 22 males (27-72) of .517 (.075). This study also indicates that 650 and 1000? ? were not sufficient to alter bone formation in the human femur bone cores using this loading regiment. Future studies will examine different loading cycles, magnitude of loading strains, and loading waveforms.