

# EFFECTS OF EXERCISE IN TRABECULAR AND CORTICAL BONE OF OSTEOPENIC RATS: A BIOMECHANICAL STUDY

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## INTRODUCTION

Osteoporosis bone loss occurs most frequently in postmenopausal women and in the elderly. Primary osteoporosis occurs in both genders; it often follows menopause in women and occurs later in men [1].

Estrogen deficiency after menopause is the primary cause of increased bone turnover and progressive reduction in bone mass and strength in women [2, 3]. Current strategies for the prevention of osteoporotic fractures focus on minimizing bone loss after menopause, normalizing bone turnover and even increasing bone mass [4].

The risk of fracture is greater at skeletal where trabecular bone is predominant. The most common fractures sites are in the head of the femur, vertebrae and distal radius [1].

The prevention and treatment of osteoporosis would be facilitated considerably if nonpharmacological modifiable lifestyle strategies could prove to be effective [5]. Exercises are one of these strategies, that are currently used and whose effects may be positive on bones.

The purpose of this study was to evaluate the effects of exercise in trabecular and cortical bone of osteopenic rats.

## METHODS

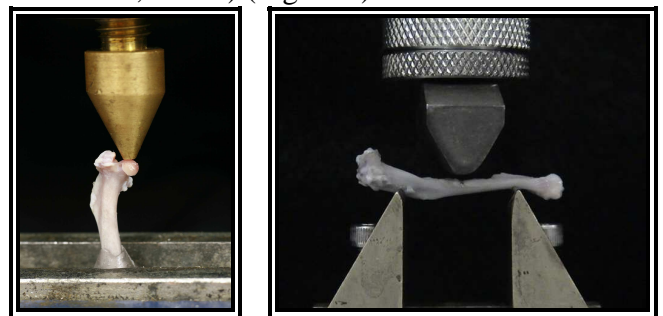
This study was approved by our Institutional Review Board: Ethical Committee in Animals Experiment.

Forty-eight three-month-old female Wistar rats were randomly assigned to six groups (n=8/group): (1) control, (2) osteopenic and sedentary, and (3) osteopenic and exercised animals.

The experimental period lasted 140 days and animals from group three were submitted to a treadmill running exercise two months after ovariectomy, after osteopenia installation [6, 7].

Physical exercise program consisted of running on a flatbed treadmill. Rats ran four days a week, one hour per day during 12 weeks, at a speed of 15 m/min from the beginning of the training until the sixth week. Then the speed was increased to 19 m/min during the remaining six weeks.

At the end of the experiment, femurs and tibiae were tested in an universal testing machine (EMIC<sup>®</sup> DL 10000, Brazil) (Figure 1).



**Figure 1.** Mechanical testing of femur and tibia: flexion-compression test and three-point ventral bending test, respectively.

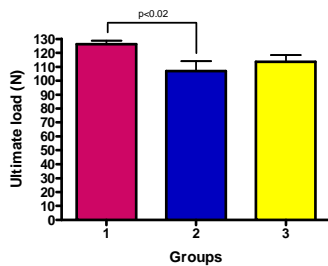
Data were analyzed using analysis of covariance - ANOVA One Way Analysis of Variance to test the differences between groups. The level of significance was set at 5%.

## RESULTS AND DISCUSSION

Successful ovariectomy was confirmed at necropsy as uterus atrophy. Uteri mass of ovariectomized rats was significantly lower than uteri mass in control groups ( $p < 0.0001$ ).

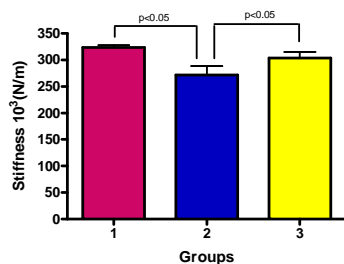
The mean values of ultimate load in femurs were: 1 ( $126.3 \pm 7.1$ ) N; 2 ( $106.9 \pm 20.1$ ) N and 3 ( $113.6 \pm$

13.7) N. There was statistical difference between groups 1 and 2 ( $p < 0.02$ ) (Graph 1). It shows that, exercise could return the ultimate load of trabecular bone to its original state.



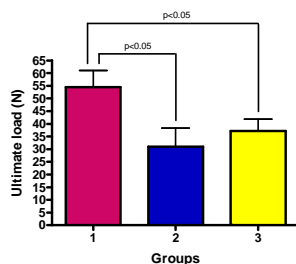
**Graph 1.** Mean and standard deviation values of ultimate load in femurs.

The mean values of stiffness in femurs were: 1 ( $323.3 \pm 13.1$ )  $10^3$ N/m; 2 ( $271.8 \pm 47.9$ )  $10^3$ N/m and 3 ( $303.6 \pm 32.5$ )  $10^3$ N/m. There was statistical difference between groups 1 and 2 ( $p < 0.04$ ) and 2 and 3 ( $p < 0.05$ ) (Graph 2). This result shows that exercise could return the stiffness of trabecular bone to its original state. Same behavior was found in ultimate load.



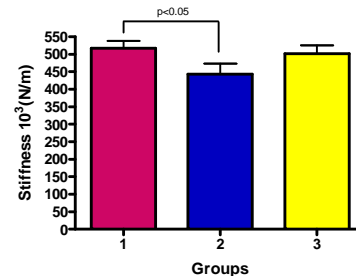
**Graph 2.** Mean and standard deviation values of stiffness of femurs.

The mean values of ultimate load in tibias were: 1 ( $54.5 \pm 18.5$ ) N; 2 ( $31.0 \pm 20.6$ ) N and 3 ( $37.2 \pm 13.1$ ) N. There was a statistical difference between groups 1 and 2 ( $p < 0.001$ ) and 1 and 3 ( $p < 0.02$ ) (Graph 3). It shows that, exercise could improve the ultimate load of tibia, but was not able to return the bone to its initial state.



**Graph 3.** Mean and standard deviation values of ultimate load of tibias.

The mean values of stiffness in tibias were: 1 ( $516.6 \pm 62.0$ )  $10^3$ N/m; 2 ( $442.5 \pm 87.3$ )  $10^3$ N/m and 3 ( $501.4 \pm 68.5$ )  $10^3$ N/m. There was statistical difference between groups 1 and 2 ( $p < 0.05$ ) (Graph 4). This finding shows that exercise could return the stiffness of tibias to its original state.



**Graph 4.** Mean and standard deviation values of stiffness of tibias.

After osteopenia installation, the ultimate load and stiffness of femurs returned to its normal state by means of exercise practice. In tibias, the stiffness also returned to its normal state with exercise, but not ultimate load.

## CONCLUSIONS

Data from our study suggest that an exercise program may recuperate bony resistance, which was decreased by osteopenia. Thus, we found that trabecular bones are more sensitive in response to exercise after osteopenia installation.

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