# THE EFFECT OF UNILATERAL LIMB IMMOBILIZATION ON THE TIBIA AND FEMUR OF MOUSE

Timo Jämsä [1], Antti Koivukangas [1], Jorma Ryhänen [2], Pekka Jalovaara [1,2] and Juha Tuukkanen [1]

[1] University of Oulu, Oulu, Finland

[2] Oulu University Hospital, Oulu, Finland

Email: timo.jamsa@oulu.fi

## INTRODUCTION

Mechanical stimuli are essential for the skeleton, and immobilization produces rapid bone loss in the weight-bearing bones (Peng et al. 1994). It is probable that a reduction of physical activity may also affect the involutional osteopenia seen in elderly people. Immobilization of a limb provides an experimental way to study mechanical influences on bone tissue without interfering with hormonal homeostasis. The present study was carried out to evaluate densitometric and mechanical changes in the tibia and femur during unilateral limb immobilization model in mouse (Jämsä et al. 1999).

## MATERIALS & METHODS

The right hind legs of male NMRI mice were immobilized for three weeks against the abdomen by an elastic bandage with the hip joint in flexion and the knee and ankle joints in extension. Age-matched controls with no immobilization were used as controls. After sacrification, the tibiae and femora were dissected out.

The bones were scanned using a peripheral quantitative computed tomographic pQCT system (Norland Stratec XCT 960A) using a voxel size of 0.092 x 0.092 x 1.25 $mm^2$ and an attenuation threshold value of 0.93 $cm^{-1}$ for cortical bone.

The tibial diaphysis was scanned at mid-shaft (Jämsä et al. 1998a) and at the proximal metaphysis, 3 mm from the proximal end of the bone. The femoral neck was scanned with the femoral neck in an axial direction (Jämsä et al. 1998b). Total and cortical bone mineral content (BMC), total and cortical bone mineral density (BMD), and cross-sectional area (CSA) were used for analyses.

The three-point bending strength of the tibial and femoral shaft and the strength of the femoral neck in axial and lateral loading configurations (Jämsä et al. 1998b) were measured (Fig. 1).

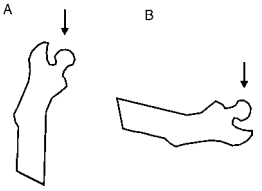


**Figure 1:** (A) Axial and (B) lateral loading of the femoral neck.

## RESULTS AND DISCUSSION

Body weight decreased by 13.5% ($p < 0.001$) during the immobilization, indicating an overall decreased activity in this model. The pQCT analysis showed that CSA, BMC and

BMD were significantly reduced at all three scan sites in both legs of the immobilized animals compared with the controls. However, with the exception of BMD of the tibial diaphysis, only the femoral neck showed a statistically significant difference between the immobilized and contralateral leg. The cortex was found to be a dominant discriminator at the femoral neck, which is in good agreement with the former findings that bone loss does not only occur in trabeculae but is accompanied by a decrease in cortical thickness (Weiss et al. 1991).

Mechanically, the tibia was a more sensitive indicator of bone loss in diaphyseal bending strength than the femur. The femoral neck also showed decreased strength, and the difference between the immobilized leg and the contralateral leg was most clearly seen in the lateral loading of the femoral neck. (Fig. 2)

## SUMMARY

We conclude that three weeks of hind limb immobilization weakened the tibia and femur significantly compared to their contralateral counterparts. The reduction was more significantly seen in the mechanical bending strength than in the pQCT evaluation. The femoral neck showed more significant weakening than the diaphysis or the tibial metaphysis, and lateral loading was the most sensitive indicator of bone loss.

## REFERENCES


Peng, Z., Tuukkanen, J., Zhang, H., Jämsä, T., Väänänen, H.K. (1994) *Bone* **15**, 523-532.

Jämsä, T., Koivukangas, A., Ryhänen, J., Jalovaara, P., Tuukkanen, J. (1999) *J. Bone Miner. Res.* **14**, 1708-1713.

Jämsä, T., Jalovaara, P., Peng, Z., Väänänen, H.K., Tuukkanen, J. (1998a) *Bone* **23**, 155-161.

Jämsä, T., Tuukkanen, J., Jalovaara, P. (1998b) *J. Biomech.* **31**, 723-729.

Weiss, A., Arbell, I., Steinhagen-Thiessen, E., Silbermann, M. (1991) *Bone* **12**, 165-172.


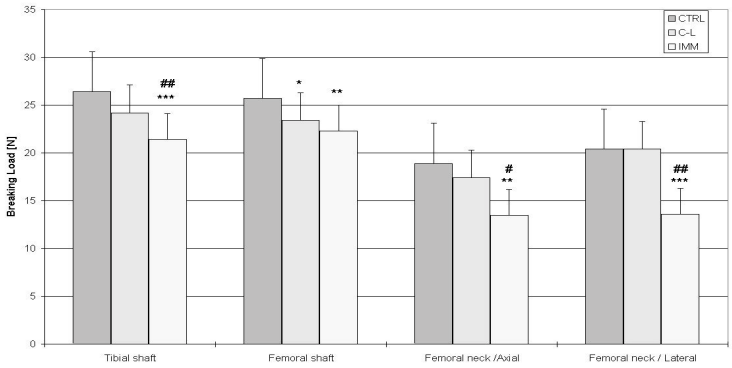


**Figure 2:** Breaking load of the bones of the immobilized (IMM) and contralateral (C-L) legs and controls (CTRL).