INTRODUCTION

The spine play very crucial role in bearing body weight. The loads acting upon a vertebra are borne by vertebral bodies and facet articulations. The vertebra has a composite structure, composed of large trabecular bone surrounded by thin cortical bone. The cortical and trabecular components share the load when the vertebra undergoes axial loading. The distribution and transmission pathway of the load within a vertebral body is still not well understood despite of some studies in the literature (Rockoff 1969, Cao 2001). The strength of these two components of bone and distribution of the loads between them determines the capability of the spine to resist compressive fractures. In addition, the vertebra is affected severely by osteoporosis changing the load distribution across the vertebra and increasing likelihood of vertebral fracture. Therefore, it is very important to understand the contribution of cortical and trabecular bone to load bearing applying on a vertebra. The present study was thus designed to quantify the percentages of the load transmitted by the cortical and trabecular bone.

METHODS

Nine vertebra selected from T10, T11 and T12 levels was separated and surrounding musculature was removed. Then, each vertebra was circumferentially defatted and cleaned using alcohol and ether for strain gauge application at the mid level of the vertebral body. Four uniaxial strain gauges were laterally and anteriorly attached to the cortex in parallel to the longitudinal axis of each vertebra using cyanoacrylate. The specimens were then supported with polyester resin from superior and inferior endplates to generate even surfaces for compression. Each vertebra was placed in MTS Alliance RT/10 materials testing machine and exposed to compressive load by two platens. The testing is conducted at 1 mm/min and 5 mm/min rate of loading until 400 N load for six cycles. After intact testing, the inferior endplate of each vertebra is partially removed leaving the cortical margin intact and tested again. Then, 25% of the trabecular bone was meticulously removed and the specimen was tested again. The area calculations were done using image analysis software (Scion, NIH) from the picture of the inferior crossection of each vertebra. The same procedure was repeated for 50%, 75% and 100% conditions.

The strain, load and displacement data were collected and the data from last cycle were used for analysis. Using the strain data from “100% removal” the
percentage of the load at the cortical bone was calculated for each condition.

Descriptive analysis and Friedman test were used to detect the differences between the groups.

RESULTS AND DISCUSSION

The load sharing was calculated and analysis was done separately for each gauge. The mean of the data from four strain gauge showed that 35.94% and 34.60% of the total load was experienced by cortex in intact vertebra when loaded at the rate of 1 mm/min and 5 mm/min respectively. (Figure 1, 2)

At the rate of 1 mm/min, the gauges did not show significant changes in load sharing until 75% of trabeculae were removed (p>0.05). On the other hand, only two gauges detected significant changes in load at the cortex after 50% removal of trabecula when tested at the rate of 5 mm/min (p<0.05).

Statistical analysis did not show significant difference in load sharing among the four different region of strain measurement after the trabecular bone was removed (p>0.05). However, anterior gauges yielded significant difference in the amount of load borne by cortex in intact specimens (p<0.05).

SUMMARY

In this study, the authors investigated and quantified the contribution of cortical and trabecular bone to load bearing within the vertebral body when axially loaded.

Results suggested that the cortical bone took almost 35% of the total axial load acting upon a vertebra. Moreover, this percentage did not show significant change even though the trabecular bone vanished 50%.

REFERENCES