LATERAL BONE DENSITY VARIATIONS IN THE SCOLIOTIC SPINE

Assoc Prof Clayton Adam, Dr Robert Labrom, Dr Geoffrey Askin
Queensland University of Technology
Brisbane
Australia

Introduction

Adolescent Idiopathic Scoliosis (AIS) is the most common deformity of the spine, affecting 2-4% of the population. Previous studies have shown that the vertebrae in scoliotic spines undergo abnormal shape changes, however there has been little exploration of how AIS affects bone density distribution within the vertebrae.

Methods

In this study, existing pre-operative CT scans of 53 female idiopathic scoliosis patients with right-sided main thoracic curves were used to measure the lateral (right to left) bone density profile at mid-height through each vertebral body. Five key bone density profile measures were identified from each normalised bone density distribution, and multiple regression analysis was performed to explore the relationship between bone density distribution and patient demographics (age, height, weight, body mass index (BMI), skeletal maturity, vertebral level, and scoliosis curve severity).

Results

At the apical vertebra, mean bone density at the left side (concave) cortical shell was 23.5% higher than for the right (convex) cortical shell, and cancellous bone density along the central 60% of the lateral path from convex to concave increased by 13.8%. The centre of mass of the bone density profile at the thoracic curve apex was located 53.8% of the distance along the lateral path, indicating a shift of nearly 4% toward the concavity of the deformity. These lateral bone density gradients tapered off when moving away from the apical vertebra. Multi-linear regressions showed that the right cortical shell peak bone density is significantly correlated with skeletal maturity, with each Risser increment corresponding to an increase in mineral equivalent bone density of 4-5%. There were also statistically significant relationships between patient height, weight and BMI, and the gradient of cancellous bone density along the lateral path. Bone density gradient is positively correlated with weight, and negatively correlated with height and BMI, such that at the apical vertebra, a unit decrease in BMI corresponds to an almost 100% increase in bone density gradient.

Discussion

This study demonstrates that AIS patients have a marked convex/concave asymmetry in bone density for vertebral levels at or near the apex of the scoliotic curve. To the best of our knowledge, the only previous studies of bone density distribution in AIS are those of Périé et al [1,2], who reported a coronal plane 'mechanical migration' of 0.54mm toward the concavity of the scoliotic curve in the lumbar apical vertebrae of 11 scoliosis patients. This is comparable to the value of 0.8mm (4%) in our study, especially since our patients had more severe scoliotic curves. From a bone adaptation perspective, these results suggest that the axial loading on the scoliotic spine is strongly asymmetric.

References

1. Périé D, Curnier D, Sales De Gauzy J, 2003. Correlation between nucleus zone migration within scoliotic intervertebral discs and mechanical properties distribution within scoliotic vertebrae. Magnetic Resonance Imaging 21:949–953.

2. Périé D, Curnier D, Sales De Gauzy J, Baunin C, Hobartho MC, 2001. Tomodensitometry measurements for in vivo quantification of mechanical properties of scoliotic vertebrae. Clinical Biomechanics 16:373-9.

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Adam C, Labrom R, Askin G

Presenting Author(s)

Assoc Prof Clayton Adam: School of Engineering Systems, QUT, GPO Box 2434, Brisbane, Brisbane, Australia
Email: c.adam@qut.edu.au
Ph: 0405148686

MEMBERSHIP

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Abstract created by Clayton Adam - Ph: 0405148686 Email: c.adam@qut.edu.au