Introduction

The scientific progress of therapeutic techniques and surgical interventions used in the treatment of low back pain (LBP) has been hampered by the lack of a routine clinical method for measuring lumbar spinal motion in three dimensions during gross anatomical movements and functional activities. The objective of this study was to establish such a routine method and to determine the influence of age, gender, height and body mass on the range of motion exhibited by the non-pathological lumbar spine.

Methods

One hundred subjects with no history of recent low back pain participated in the study. In order to control for age and gender the subject were recruited in 10 cohorts of 10 subjects. There were 5 male cohorts, one for each decade of adult life (20s, 30s, 40s, 50s, 60s & 70s+) and 5 female cohorts. Height and mass were recorded but not controlled. Each subject performed the gross movements of forward flexion, backward extension, side flexion to the left and right and axial rotation to the left and right at free pace. The angular displacement of the lumbar spine in three dimensions was recorded during each movement using a three space Isotrak system manufactured by Polhemus Navigation Systems (figure 1).

Figure 1: Isotrak system

with a modified method of attachment (Figure 2) previously shown to be repeatable to within two degrees, to show good agreement with published X-ray data and to overcome the attachment problems experienced by other authors. In this attachment method the source and sensor were mounted on separate adjustable plastic wedges backed with a piece of dense foam. The wedges were then attached to the subject in prone lying using double-sided tape and held in place by straps made of inextensible nylon. The source was attached to the pelvis at the level of S1 and the sensor over the spinous process of T12 (Figure 3).
Results & Discussion
The range of motion was calculated for each cohort of 10 subjects and for the 100 subjects collectively. These data are presented in table 1:
For the 100 healthy subjects tested the lumbar spine possessed on average 55.4 degrees of flexion, 23.1 degrees extension, 21.7 degrees lateral bending to the left, 22.8 degrees lateral bending to the right, 14.1 degrees axial rotation to the left and 13.1 degrees axial rotation to the right. Univariate regression analysis using a p value corrected using the method of Bonneferroni (P=0.012) indicated that age caused a loss of 1.2 degrees of flexion per decade, 3.2 degrees of extension, 1.8 degrees side flexion to both sides and 0.8 degrees axial rotation to the left. Females showed greater extension (6.8 degrees) and axial rotation (3.5 degrees), Height was only weakly related to one movement while mass was weakly related to four. These results have confirmed that age leads to a general reduction in mobility in the lumbar spine and that females exhibit more flexibility than males in extension and rotation. Further the ability to detect these small changes with statistical significance in a sample of 100 subjects indicates that the method is precise and suitable for routine clinical use to evaluate treatment of the diseased or injured low back.

References
Van Herp G, Rowe P. J., Salter P & Paul J. P (2000), Three dimensional lumbar spinal kinematics: a study of range of movement in 100 healthy subjects aged 20 to 60+ years, Rheumatology, Vo 39, 1337-40

Acknowledgements
This work was supported by a QMUC research studentship.