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# SPINAL ACCELERATIONS ON THEME PARK RIDES

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## INTRODUCTION

While theme park rides are carefully designed, the spinal accelerations experienced by riders are not well known, thus their suitability for paediatric patients who have undergone surgery for Adolescent Idiopathic Scoliosis (AIS) is not clear. Scoliosis surgery involves spinal fusion, a process which takes 3-6 months post-surgery for bridging bone to grow between adjacent vertebrae. Currently, doctors advise their patients on activities which are suitable to participate in post surgery. This project, initiated by Surgeons and the Paediatric Spine Research Group at the Mater Hospital, Brisbane, aims to determine the suitability of this popular activity for post surgery AIS patients.

## METHODS

Initial background research was undertaken on the spine and scoliosis. This research was furthered by reviewing literature on spinal accelerations and their effects during various activities. A small, durable and waterproof accelerometer measurement system was then designed to measure acceleration forces exerted on the human spine during daily activities and riding local theme park rides. Three bi-axial MEMS ADXL321 accelerometers, measuring to  $\pm 18$ Gs were attached to the skin surface, positioned at T4 and L1, the vertebrae above and below the limits of the average scoliosis surgical instrumentation respectively, and C4.

Preliminary testing was performed during daily activities in order to calibrate the equipment as well as to provide corroborative data for work cited in the literature. The activities included; self-paced walking, walking up and down stairs, coughing, sneezing, stand-to-sit and sit-to-stand movements simulating entry and exit from a ride carriage. Testing of accelerations on theme park rides was undertaken at local amusement parks.

Both the preliminary and the theme park ride testing were performed on the same subject, a healthy 21 year old female with no history of spinal surgery or scoliosis. Age aside, the subject's weight and height were close to those of the average AIS surgery patient.

## RESULTS

Testing resulted in the following findings for maximum acceleration during selected activities: self-paced walking, 2.3Gs; medium paced jog, >3Gs; walking downstairs, 2.9Gs; and standing to sitting, >3Gs. These acceleration levels are inline with previous levels reported in the literature<sup>1,2</sup>. Initial testing on theme park rides indicated peak accelerations generally between 4 and 5Gs with little attenuation from L1 to C4. Several high magnitude, short duration peaks were also measured.

## DISCUSSION

The measured spinal accelerations on various local theme park rides were compared to spinal accelerations experienced during acceptable post surgery activities determined by health professionals. Initial findings suggest slightly higher G forces are experienced riding theme park rides, with little attenuation from L1 to C4. In addition, the data measured was used to perform a biomechanical assessment of the scoliotic spine in comparison to the 'normal' spine.

## REFERENCES

1. Ng, T.P, Duma, S.M. and Kress, T.A., Thoracic and lumbar spine accelerations in everyday activities, *Biomed Sci Instrum*, 42:410-5,2006.