THE MEASUREMENT OF APPLIED FORCES DURING ANTERIOR SINGLE ROD CORRECTION OF ADOLESCENT IDIOPATHIC SCOLIOSIS

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INTRODUCTION

Adolescent idiopathic scoliosis (AIS) is the most common form of spinal deformity in paediatrics, prevalent in approximately 2-4% of the general population (LaMontagne, Hepworth et al. 2004). While it is a complex three-dimensional deformity, it is clinically characterised by an abnormal lateral curvature of the spine. The treatment for severe deformity is surgical correction with the use of structural implants. Anterior single rod correction employs a solid rod connected to the anterior spine via vertebral body screws. Correction is achieved by applying compression between adjacent vertebral body screws, before locking each screw onto the rod. Biomechanical complication rates have been reported as high as 20.8%, and include rod breakage, screw pull-out and loss of correction (Reddi, Clarke et al. 2008). Currently, the corrective forces applied to the spine are unknown. These forces are important variables to consider in understanding the biomechanics of scoliosis correction. The purpose of this study was to measure these forces intra-operatively during anterior single rod AIS correction.

METHODS

A calibrated strain gauge force transducer was retrofit to the surgical tool used to apply compressive force between each pair of vertebral body screws. During surgery, the transducer was connected to a data logger and strain output continuously logged on a PC throughout the compression of each joint. After compression was achieved, the final strain was used to calculate an applied corrective force for each joint. Routine intra-operative fluoroscope images were taken during compression of each joint as a visual aid for the surgeon. The angle between adjacent vertebral body screws was measured both before and after compression of each joint and the difference in angles was calculated as a measure of joint correction achieved by the applied force.

RESULTS

Intra-operative force measurements were performed for a total of 14 AIS patients (aged 11-19 years). A total of 88 joints were instrumented with an average of 6.3 joints per patient. The measured forces varied within the range of 100N and 1096N. The average force applied to a joint was 545 N (standard deviation, ±226.8N). The largest forces were measured at joint levels close to the apex of the deformity. The average measured joint correction was 4.7 degrees (standard deviation, ±2.6 degrees) with a maximum recorded correction of 12.6 degrees. A linear relationship was observed between applied force and joint correction (R^2=0.38).

DISCUSSION

The corrective forces applied intra-operatively during anterior single rod scoliosis correction were found to vary widely among joint levels and patients. Force is not applied evenly, with higher forces generally applied towards the apex of the curve. The measurement of these forces contributes to the understanding of the biomechanics of anterior scoliosis correction. Routine force measurement may uncover relationships between applied corrective forces, post-operative correction achieved, and implant related complication rate.

LaMontagne, L. L., Hepworth, J. T., Cohen, F. and Salisbury, M. H. (2004). Adolescent Scoliosis: Effects of Corrective Surgery, Cognitive-Behavioral Interventions, and Age on Activity Outcomes.*Applied Nursing Research* **17**(3): 168-177.

Reddi, V., Clarke, D. V., Jr. and Arlet, V. (2008). Anterior thoracoscopic instrumentation in adolescent idiopathic scoliosis: a systematic review.*Spine (Phila Pa 1976)* **33**(18): 1986-94.