A Computational Investigation Of Minimal Invasive Spine Surgery

Sten Rasmussen¹, John Rasmussen²
¹Orthopedic Surgery Research Unit, Aalborg University Hospital Science and Innovation Center, Aalborg, Denmark
²Aalborg University, Aalborg, Denmark

INTRODUCTION
- MISS has been used for more than a decade. The reasoning is the perception that a gentle surgery is more beneficial for the patient. Especially since traditional open spine surgery (TOSS) has several reported limitations including blood loss, muscle pain and infection.
- Minimal invasive insertion systems are designed to minimize the approach-related morbidity of traditional lumbar pedicle fixation. A major part of reducing morbidity might be the preservation of the tendon attachment of the muscle.
- We hypothesized that MISS in a computational model reduce the muscular load.

AIM
The aim of the study was to investigate the implication of preserving tendon attachment using MISS compared to TOSS.

METHODS
- The computational investigation is based on the AnyBody Modeling System version 5.2 (AnyBody Technology, Aalborg, Denmark) and its associated model library, the AnyScript Managed Model Repository, version 1.5.
- The library allows for composition of ad-hoc models by combination of individual body parts but the present investigation used the entire body comprising a spinal part, upper extremities and lower extremities, totaling more than 1000 independently activated muscle-tendon units.
- The stiffness of the joints can consequently be controlled in the model, effectively allowing for fusion of individual joints, thus requiring neighboring joints to assume a larger fraction of the total pelvis-thorax angle. The model is subjected to the basic activity of daily living, namely normal gait.
- The gait data was recorded with a male subject 26 years of age, stature of 1.73 m and body mass 62 kg.

RESULTS
- MISS is preferable to TOSS from the point-of-view of muscle activation, except for the case of L5S1 fusion.
- It is remarkable that the case of L3L4 appears to be more sensitive to the TOSS approach than any of the other cases, including the double fusion L4S1, and that fusions with the TOSS approach at more proximal levels generally appear to affect the muscle activation more than distal levels.
- In the MISS approach, the tendency is the opposite.
- Another remarkable finding is that L4L5TOSS results in significantly more increase in muscular load than the more elaborate L4S1TOSS. This is because both procedures sacrifice muscles spanning L5S1 but only the L4S1 procedure provides force and moment stabilization of L5S1by fusion.

CONCLUSIONS
- The model indicates that the muscle preservation obtained by MISS leaves the patient with significantly better muscular functionality compared with TOSS.
- The investigation has only considered the muscular effect of the two approaches, while remaining parameters such as joint forces or loads on the fused joint remain for future investigation.

Presenting author:
Sten Rasmussen
Orthopedic Surgery Research Unit
Research and Innovation Center
DK-9000 Aalborg, Denmark
Phone: +45 25 52 04 62
Mail: sten.rasmussen@rn.dk

NORTH DENMARK REGION
Orthopaedic Surgery Research Unit

AALBORG UNIVERSITY HOSPITAL