A Computational Investigation Of Minimal Invasive Spine Surgery

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Publication date:
2014

Document Version
Early version, also known as pre-print

A Computational Investigation Of Minimal Invasive Spine Surgery

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Introduction

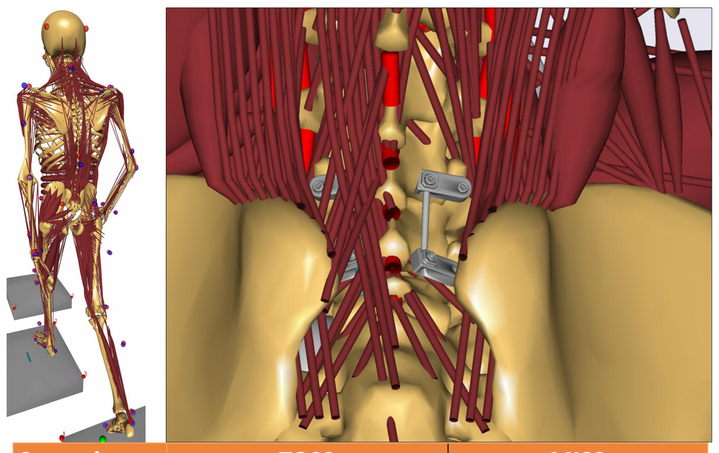
- **MISS has been used for more than a decade. The reasoning is the perception that a gentle surgery is more beneficial for the patient. Especially since traditional open spine surgery (TOSS) has several reported limitations including blood loss, muscle pain and infection.**
- **Minimal invasive insertion 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

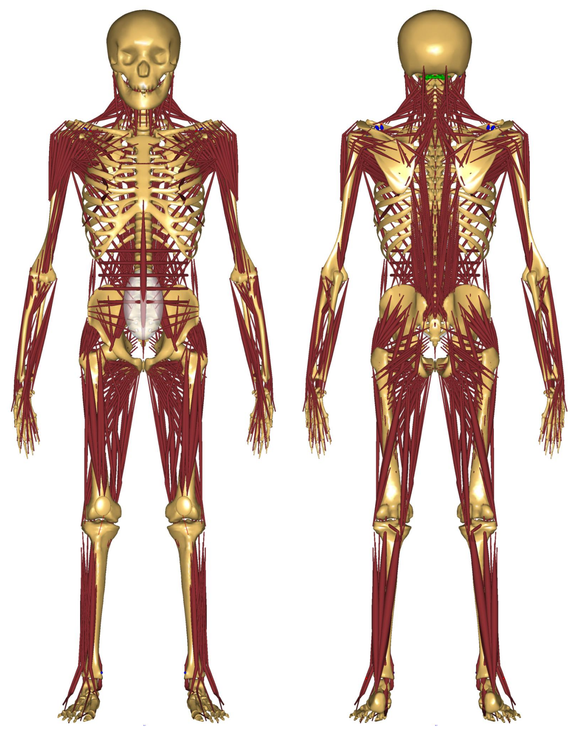
The aim of the study was to investigate the implication of preserving tendon attachment using MISS compared to TOSS.

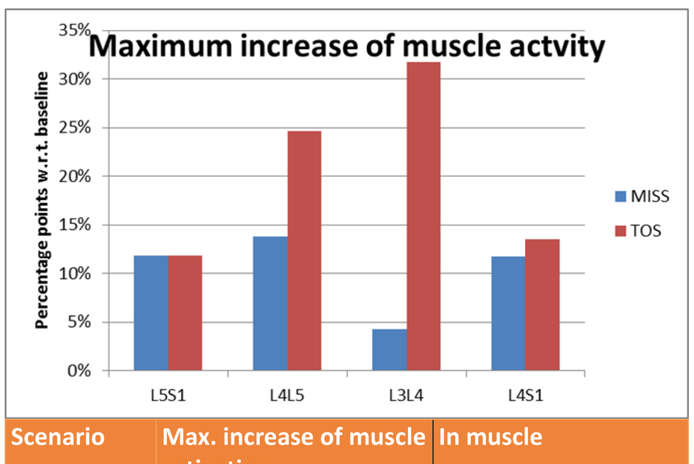
Methods

- **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.**



Scenario	TOSS	MISS
Baseline	No change in model	
L5S1	Joint fused* Adjacent muscles sacrificed	Joint fused*
L4L5	Joint fused* Adjacent muscles sacrificed	Joint fused*
L4L5	Joint fused* Adjacent muscles sacrificed	Joint fused*
L3L4	Joint fused* Adjacent muscles sacrificed	Joint fused*
L3L4	Joint fused* Adjacent muscles sacrificed	Joint fused*
L4S1	Joint fused* Adjacent muscles sacrificed	Joint fused*
L4S1	Joint fused* Adjacent muscles sacrificed	Joint fused*





Scenario	Max. increase of muscle activation	In muscle
L5S1MISS	12%	psoas major
L5S1TOSS	12%	psoas major
L4L5MISS	14%	multifidus
L4L5TOSS	25%	obliquus internus
L3L4MISS	4%	psoas major
L3L4TOSS	32%	obliquus internus
L4S1MISS	12%	psoas major
L4S1TOSS	14%	erector spinae

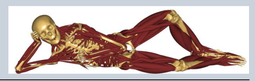
Results

- **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



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