EFFECT OF ABDOMINAL MUSCLES ELONGATION DURING PREGNANCY ON L4-L5 SPINAL LOAD USING A FINITE ELEMENT MODEL

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Summary

This study simulates the effect of abdominal muscles elongation during prognancy on L4-L5 spinal load by using a model of thoracolumbar spine muscular system based on muscle biological parameters which can simulate effects of different muscular disorders on loading pattern within the spinal column.

1. Introduction

During pregnancy the risk of low back pain is increased and raises important questions about the role of abdominal muscles in spinal stabilisation. For instance, the abdominal wall muscles undergo dramatic elongation, associated with force losses and inability to stabilise the pelvis against resistance [1]. Considering Finite element (FE) models have been useful in predicting spinal [2, 3]; The aim of this study was to use a FE model of the thoracolumbar spine muscular system simulating active muscle contraction forces in terms of biological parameters (2) Simulating the effect of abdominal muscles elongation during pregnancy on L4-L5 spinal load.

2. Methods

A FE model accounting for nonlinear passive properties of the thoracolumbar ligamentous spine was used [2, 3]. Muscle architecture with 11 muscles was considered (see Fig. 1) [4]. A phenomenological model of biological parameters (voltage, frequency, length) was used to represent active muscle forces [2, 5] represented by the equation $F_{active} = F_0 f_\lambda f_v f_t$, where F_0 is the maximum isometric force, f_λ is the force–stretch relationship, f_v is the force–voltage relationship and f_t is the force–time relationship.
Relaxed upright standing posture and upright standing posture while holding a load was simulated [2,3]. Two cases of healthy and pregnant subjects were simulated. Considering pregnancy is accompanied by dramatic elongation in abdominal muscles, the stretch parameters in abdominal muscle were fitted to the highest possible values in physiologic range. Optimization with the cost function of sum of squared muscle stresses was used [2, 3].

3. Results

In relaxed upright standing posture, intradiscal pressure at L4-L5 level was comparable with those reported in the literature [3, 6]. In relaxed upright standing posture of the pregnant subject, the computed force at L4-L5 level increased by 114.54% in A-P component and by 45.62% in I-S component in comparison with the healthy subject.
In holding load posture of the pregnant subject, the computed force at L4-L5 level increased by 25.07% in A-P component and by 17.64% in I-S component in comparison with the healthy subject (see Fig. 2).

4. Conclusion

In this study a biomechanical model of the thoracolumbar spine has been used which simulates active response of skeletal muscles in terms of intrinsic properties of muscle.
The model could predict increases in forces at L4-L5 vertebral level in both of relaxed upright standing posture and holding load posture with elongation in abdominal muscles compared with those of the same posture with no elongation, indicating the effect of pregnancy and elongation of muscles in abdominal region on intradiscal pressure and therefore on low back pain.

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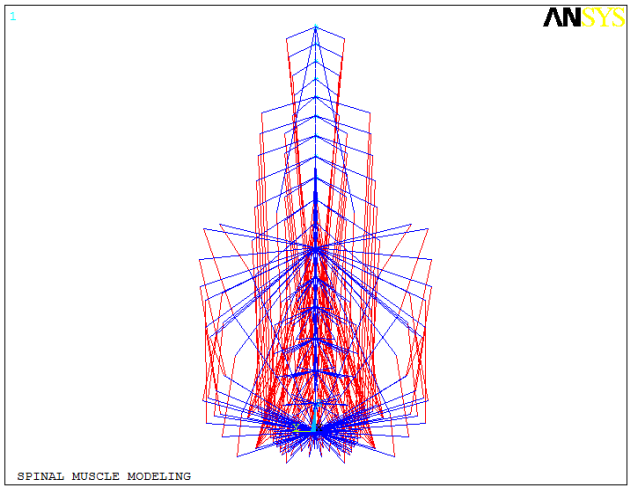

Figure 1. Sagittally symmetric muscle architecture with 11 local and global muscles

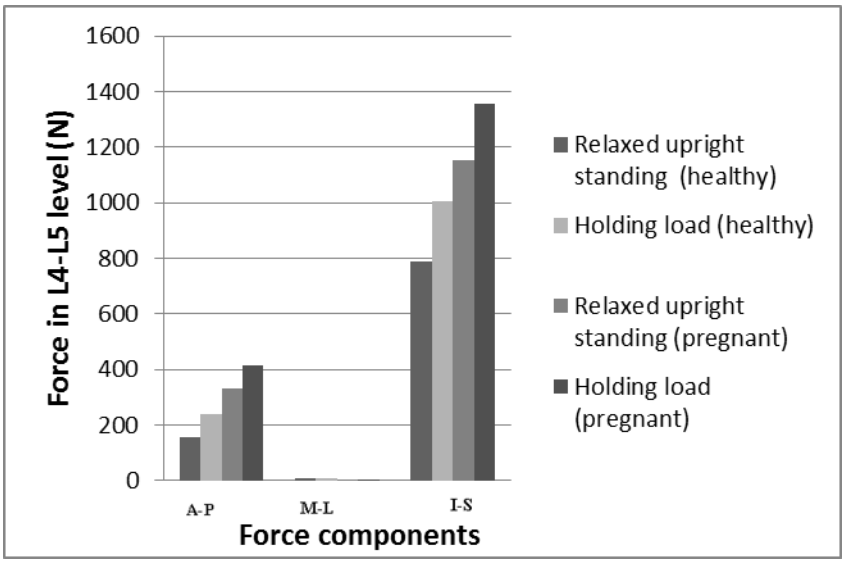

Figure 3. Force components at L4-L5 vertebral level in three simulated postures for different loading components; anterior-posterior (A-P), medial-lateral (M-L) and inferior-superior (I-S)