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

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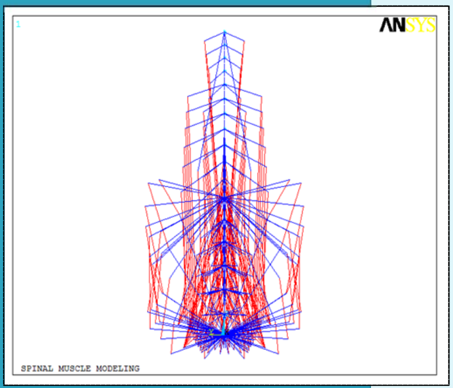


**Figure 1. Sagittally symmetric muscle architecture with 11 local and global muscles**

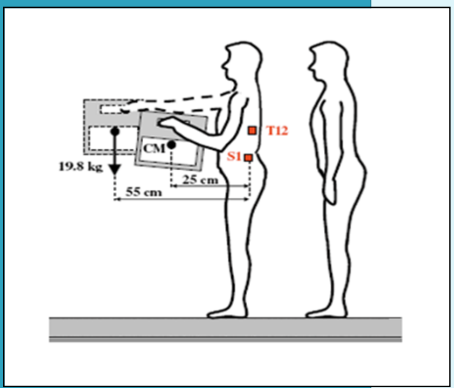


**Figure 2. A schematic presentation of the simulated tasks: neutral relaxed upright standing posture and holding symmetrically a box of 19.8 kg close to the chest.**

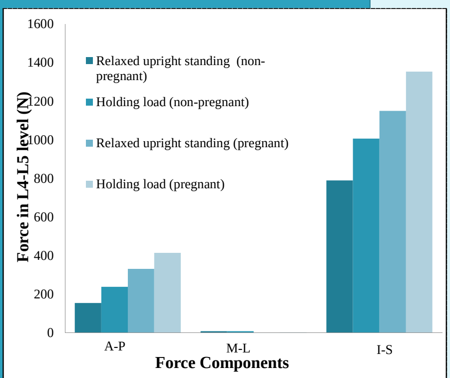


**Figure 3. Force components at L4-L5 vertebral level in three simulated postures for different loading components; anterior-posterior (A-P), medial-lateral (M-L) and inferior-superior (I-S)**

## 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]. Proper prevention, diagnosis, and treatment of low back pain require a correct evaluation of spinal muscle forces and loads experienced by the spine. Finite element (FE) model studies have been useful in predicting spinal loads in conditions where experimental analyses were not possible [2, 3]. The aim of this study was to develop a finite element model of the thoracolumbar spine muscular system simulating active muscle contraction forces in terms of biological parameters (voltage, frequency, length) [2] Simulating the effect of abdominal muscles elongation during pregnancy on L4-L5 spinal load.**

## METHOD

**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). Muscles incorporated into the model were External Oblique, Internal Oblique, Rectus Abdominus, Thoracic Multifidus, Lumbar Multifidus, Longissimus pars Lumborum, Ioliocostalis pars Lumborum, Longissimus pars Thoracis, Ioliocostalis pars Thoracis, Psoas and Quadratus Lumborum [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, $f_\lambda$ is the force–stretch relationship, $f_v$ is the force–voltage relationship and $f_t$ is the force–time relationship. In the analyses of the model, the pelvis was constrained. Relaxed upright standing posture and upright standing posture while holding a load was simulated (see Fig.2) [2,3]. Two cases of non-pregnant 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].**

## RESULTS

**In relaxed upright standing posture, intradiscal pressure at L4-L5 level was calculated to be 0.44 MPa which was comparable with those reported in the literature [3, 6]. Figure 2 shows the calculated forces at L4-L5 vertebral level at different postures. As shown in Fig.3, inferior-superior (I-S) components were significantly higher than anterior-posterior (A-P) and medial-lateral (M-L) components. 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 non-pregnant 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.**

## CONCLUSIONS

**The predicted forces at L4-L5 vertebral level at holding load in upright standing posture were increased compared with those of upright standing posture without load confirming that holding load in hands can increase intradiscal pressure. 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.**

## References:

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