IJAE
Vol. 122, n. 1 (Supplement): 39, 2017
ITALIAN JOURNAL OF ANATOMY AND EMBRYOLOGY

Finite Element Analysis in different Subtype of Sagittal Alignment

Giorgio Cacciola[1], Vincenzo Filardi[3], Pietro Cavaliere[3], Alessandro Pisani[3], Andrea Barbanera[4], Maria Righi[1], Claudia Previti[1], Angelo Favaloro[1]

[1] Department of Biomedical, Dental Sciences and Morphological and Functional Images, University of Messina, 98125 Messina, Italy
[2] CARECI, University of Messina, Messina, Italy
[3] Istituto Ortopedico del Mezzogiorno d'Italia "Franco Scalabrino", Messina, Italy
[4] A.O.N. SS. Cesare, Antonio e Cesare Arrigo, Alessandria, Italy

In humans, vertical posture acquisition caused several changes in bones and muscles which can be assumed as verticalization. It's widely known that six different morphological categories exist; each category differs from the others by pelvic parameters and vertebral column curvatures. Both values depend on the Pelvic Incidence, calculated as the angle between the axis passing through the rotation centre of the two femur heads and the vertical axis passing through the superior plate of the sacrum. The aim of this study is to evaluate the distribution of stress and the resulting strain along the axial skeleton using finite element analysis. The use of this computational method allows performing different analyses investigating how different bony geometries and skeletal structures can behavior under specific loading conditions. A CT of artificial bones, was used to obtain geometrical data of the model developed. Lines were imported into a commercial code in order to interpolate main surfaces and create the solid version of the model. Six different models were created according Roussouly's classification, by arranging geometrical position of the skeletal components. Loading conditions were obtained by applying muscular forces components to T1 to L5, and a fixed constrain was at the distal epiphisis of femurs. Materials were assumed as elastic; Elastic modulus of 15 GPa, a Shear Modulus of 7 GPa for bony parts; Elastic modulus of 6 MPa, a Shear Modulus of 3 MPa for cartilaginous parts [1]. Six different simulations have been carried out. Results confirm higher solicitations obtained varying configurations from case I to case VI. In particular way, first three cases seem to supply the different loading configurations spreading stresses in almost all the bony parts of the column, while the remaining others three cases produce a higher concentration of stress around the lower part of spine (L3, L4, L5). Results confirm a good agreement with those present in literature, an equivalent Von Mises average stress of 0,55 MPa was found on the intervertebral disks with the higher values reached on the lower part of the model. A comparison of results obtained for Case I with literature, shows a good agreement in terms of normal compressive force, while more evident differences can be found for shear force and sagittal moment. The results underline a relationship between PI increase, and accordingly of PT and LL, and the distribution of load forces. Load forces is exerted mainly on distal vertebrae, especially on L4 and L5.

References

[1] Alison et al. (2008) Finite element analysis of the spine: Towards a framework of verification, validation and sensitivity analysis. Medical Engineering & Physics Vol.30 Iss. 10, Dec. 2008 pp 1287-1304

[2] Galbusera et al. (2013) Influence of sagittal balance on spinal lumbar loads: a numerical approach. Colin Biomech 2013 Apr:28(4):370-7

Keywords

FEM, finite element analysis, Sagittal Balance, Lumbar Spine, Biomechanics