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Analytic Technique for Determination of Lumbar Spine's Center Of Mass: Towards A New Biomechanical Technique For Lumbar Spine Studies

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Abstract

In mechanics, the subject of center of mass or gravity is often an important one since it eases calculations and offer better understanding into the mechanics of a system. However, this has been a difficult task when it comes to the subject of biomechanics of the trunk despite of the many problems posed by the weight bearing section of the spine- the lumbar spine. The purpose of this work was to derive equations of the coordinates of center of mass or gravity of the lumbar spine that will allow theoretical determination of the trunk's center of mass at any given posture since the lumbar spine's posture varies from person to person and from one position to another. We used the equation of lumbar spine in the six degrees of freedom and an empirical density distribution function to determine the coordinates of the center of mass in the three orthogonal Cartesian coordinates. The results are presented and can be useful particularly in the estimation of forces and moments generated by muscles and tissues in the lumbar spine from an equilibrium based point of view andgenerally, the studies of kinetics of the lumbar spine.

Keywords: thermal-diffusion; heat source; magnetic field; free convection

1.0 Introduction

Background

The problem of low back pain is a global problem affecting people of all ages and job descriptions and the challenges have often been traced, primarily, to mechanical factors [1-3]. Hence the mechanics of lumbar spine needs to be studied for any given posture since human daily activities requires that the lumbar spine assume one shape or another. For example the shape of the lumbar spine for sedentary worker will differ from that of a local farmer and from that of a law enforcement worker etc.

The mechanics of the lumbar spine has been a subject of thorough studies for many years under disciplines such as Biomechanics and ergonomicsfor the purpose of addressing the myriad of health issues pose by the lumbar spine [4-9] yet this important subject matter-center of mass or gravity has remained a challenge till date [10]. This is probably due to the variability of the shape of the lumbar spine. The position of center of mass for a rigid body with a fixed shape (or mass distribution) is fixed however that of a variable shaped body such as lumbar spine varies from one position to another. Two means of determining center of mass that are commonly used include reaction board technique and a segmentation method [11, 12]. However, none of these methods could be convenient for the study of lumbar spine's center of mass given its varied nature of postures and the need to study its dynamics and stability under such postures.

Purpose

To device a more convenient way of locating the center of mass of this portion of the spine given its strategic role of weight (load) bearing [13] and the variability of its shape was the purpose of this research.

Importance

The result of this work can assist in determination of the forces and torque developed by lumbar spine muscles during any task.

2.0 Method

Problems in dynamics are better understood and easily solved when the mass center is located. The position vector of the mass center **C** of a continuous body $\boldsymbol{\tau}$, curve, surface, or solid, relative to a point **O** is

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