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STUDY ABOUT THE BIOMECHANICAL MODEL OF THE CERVICAL SPINE

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Abstract. The paper presents a study over the biomechanical model of the cervical skin and its possible movements. Biomechanical models of the human body are important tools in understanding the vibration transmissibility thru human body and the response gave by the body under the vibration action. The mechanical model represents the first step on the study of the mechanical vibration transmitted thru the human.

1. INTRODUCTION

The human body is exposed to vibration in many environments. Usually there is a desire to minimize vibration in order to reduce discomfort, interference with activities or a risk to disturb health.

Whole body vibration is happened when the body is sitting on a vibrating surface. The long time whole body vibrations which action on human operator and which are higher than some limits can produce:

- Disturbing of physical and intellectual activity;
- The leisure of different part of body, in this case the cervical skin;
- Subjective phenomenon.

The human body, under the vibration action, will amplify or will damp them, conform to the mechanical lower of vibrations, like any mass with elastic and damper properties.

The cervical vertebrae are responsible for kipping to the equilibrium of the head. That's why it is necessary to model the cervical vertebrae.

Human response to whole body vibration depends by frequencies and direction of vibrations and in the same time depends by the body position.

2. ANATOMY OF THE CERVICAL VERTEBRAE

The neck is formed by 7 pieces called cervical vertebrae and noted C1 – C7 like in figure 1.

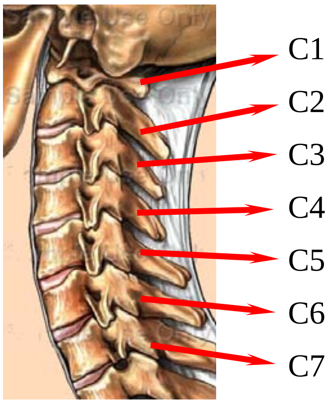

Fig. 1

Vertebrele cervicale
Atlas şi Axis
Fig. 2

C1 and C2 (Fig. 2) have special bony structures for supporting the movement of the skull.

Cervical vertebrae 3-7 are more typical (Fig. 3). Although the general structures of the cervical spine are similar to the bony structures of the lower spine, there are key differences. The typical cervical vertebrae (C3-C7) are smaller than the vertebrae in the thoracic or lumbar areas. The disc material between the bones is about half as thick. Also, the cervical vertebrae have more of a rectangular shape in the body of the bone. There are two lips on the superior surface of the body of the cervical vertebrae. These lips interlock with the vertebrae above it. The cervical vertebrae are designed to allow more range of motion than the thoracic or lumbar areas, but also provide good stability in the neck region. The spinous processes project posteriorly, the longest of which is C7 (Fig. 4). C7 is the prominent bony landmark you can feel at the base of your neck.

Cervical vertebrae C1 and C2 are different in structure than those below. C1 is called the **atlas** and is the pedestal on which the skull rests. It is called the atlas because of the image of atlas holding up the world. It does not have a body or a spinous process, but is more of a bony ring with two important facets on which the occiput of the skull rests. Cervical vertebrae C2 is called the **axis.** It also has two superior facets on which C1 rests. C2's key structure is a process called the **dens or odontoid process**, which extends superiorly from the bone. It fits into a hole or foramen in the C1 vertebrae above it

The articulation is called simfize.

Vertebrele cervicale
C3 – C5
Fig. 3

A şaptea vertebră
cervicală C7
Fig. 4

3. THE BIOMECHANICS OF CERVICAL VERTEBRAE

The typical vertebrae C3-C7 joints allow cervical flexion, extension, side bending, and rotation in the neck region [13].

Cervical Flexion – bending of the head forward or movement of the head toward the chest. C1, the atlas follows the head and moves into an **inferior** position (Fig. 5).

Cervical Extension – tipping the head backward so that the eyes look at the ceiling. The atlas follows the head and moves into a **superior** position.[12] (Fig. 6).

Sidebending – tipping the head toward the side so that the ear of one side moves toward the shoulder of that same side. This occurs both left and right (Fig. 7).

Rotation – turning of the head left or right. The nose moves over the shoulder as the head rotates (Fig. 8). The posterior tubercle of C1 rotate to the left or right, followed by the spinouses of C2 through C7 in a "Flag" effect with C7 staying on the visual midline of the neural canal.

Fig. 5

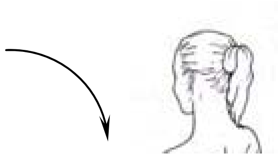

Fig. 6

Fig. 7

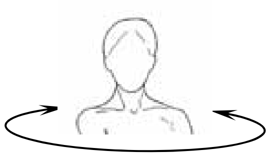

Fig. 8

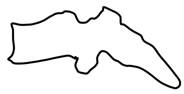

Fig. 9. The real contour of a vertebrae

The degree for every kind of moving are shoen in tabel 1.

Tabel 1.The moving amplitude of the cervical spine

Segment	Flexion	Extension	Bending	Rotation
Cervical	70^0	60^0	30^0	75^0

4. THE BIOMECHANICAL MODEL OF THE CERVICAL SPINE

The biomechanic modelling is important to estimate the input forces special in this area where it is known the input signal [6]. The exposure to long term at whole body vibration is could damage some parts of the cervical column.But the leisure depend by many other factors. One of them is the body position. So it seems beeing necessary to adapt teh position to the specified work, means working on the lathe.

The biomechanical model it is based on the real contour of a vertebrae (Fig. 9).

In the model the cervical spine is imitated dy 7 rigid bodyes. Every one of the cervical vertebrae has been considered like a rigid body with concentrate mass.The rigid bodies are conected by „hinges”.That joints are modelled like springs and dampers and the forces and torques can be transmitted thru them.

An additional body represents the head, on the upper side of the model, and the other one represents the entire body.

A view of the two dimensional model is given in figure 10.

The moving axis are given in figure 11. There are three axes: Ox from back to front; Oy from right to left and Oz from feet to head. They aqre on agree with refernces [14].

5. CONCLUSIONS

By using the proposed model and a mathematical model too, the forces in the cervical spine can be computed for different vibration stress. By comparing the forces with the endurance strenght of the spine, a valid assesment of the health risk is possible.

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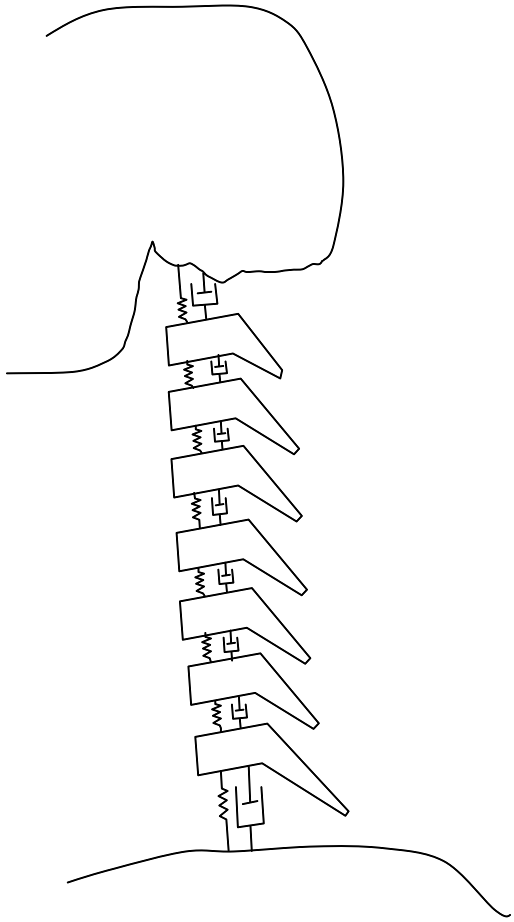

Fig. 10. Biomechanical model

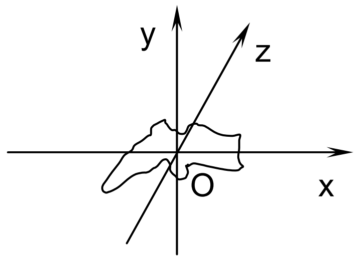

Fig. 11. The moving axes

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