THE DISPLACEMENTS OF VERTEBRAL ARCH THROUGH USE OF SPECKLE PHOTOGRAPHY METHOD

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The subject of the paper is design of model and development of methods fo investigations of deformation of osseous elements of lumbar spine. The displacements of vertebral arch at modeling the complex systems of forces were realized on real vertebrae by applying speckle photography methods. In this paper, deformation of the vertebral arch are investigated under some simulated loading conditions.

The mechanism of the so-called overload damage to the elements of the vertebral column has not been fully accourted for in spine of large number of radiological, histopathological and biochemical investigations that have been carried out in this field.

A particular attempt of this study has been undertaken to elucidate some phenomena making it possible to know the mechanism of phatogenesis of some spine diseases due to so-called effort.

Significant contributions have been made by for understanding the response of the lumbar spine (vertebral arch) under different physiological loading conditions namely standing and siting position, and flexion or extension.

The research methodology by using speckle photography method that has been developed as well as the measuring position have made it possible to make a qualitative and quantitative estimation of the displacements of the vertebral arch subjected to different loads.

The object of investigation was the vertebra L_5 in different biomechanical situations simulating its position for different configurations of the vertebral column.

The speckle method is used for analysing displacements in the direction being parallel to the surface of the object.

This method makes use of the so-called speckle effect connected with phenomena accompanying the coherent light diffusion through an optically irregular surface [2] (Fig. 1).
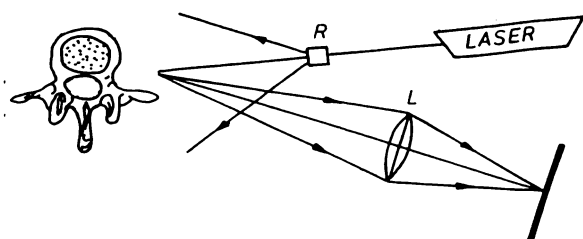

Fig. 1. Schematic diagram of speckle recording system.

The determination of the geometrical parameters of the vertebral column was performed on the basis of radiological photographs. The parameters were being determined for the selected representative group of ten men aged 24 to 42.

Based on radiograms skiagrams were constructed to be used for determining the dimensions of vertebrae and intervertebral disks as well as the geometrical shape of the part of the vertebral column. The vertebral column geometrical parameters are presented in Fig. 2.
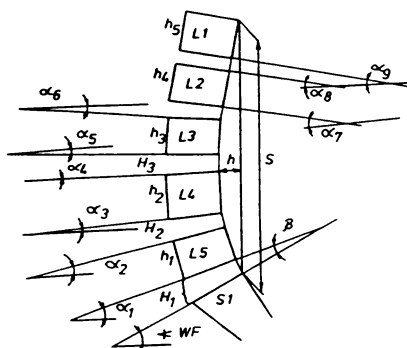

Fig. 2. Geometrical parameters determined in the course of analysing skiagrams of the lumbar part of the vertebral column.

The subject of the analysis were deformations of the isthmus with joint and spine appendices being loaded. The investigations were carried out on lumbar vertebrae L_5

from cadavers. The vertebra L_5 was selected since the results of clinical practice and the hitherto existing investigations have shown that on account of its position and functions as well the complexity of loading it is the most vulnerable to overloading [1].

Based on the above presented parameters (Fig. 2) an assumption was made of geometrical relationships between the angles of setting up the adjoining vertebrae and the directionsof forcesacting upon them (Fig. 3). Itwas assumed that the angles of the mutual inclination of movable segments are, at same time, the angles determining the directions of the actions of forces of two mutually contacting joint planes.
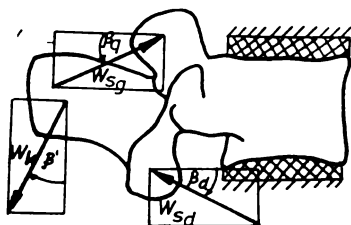

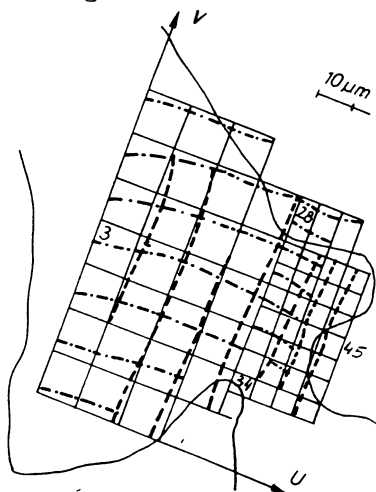Fig. 3. Scheme of loads of the investigated vertebra.

Fig. 4. Exemplary distribution of isthmus displacements U and V at the loading of spinous processus and for the extension position.
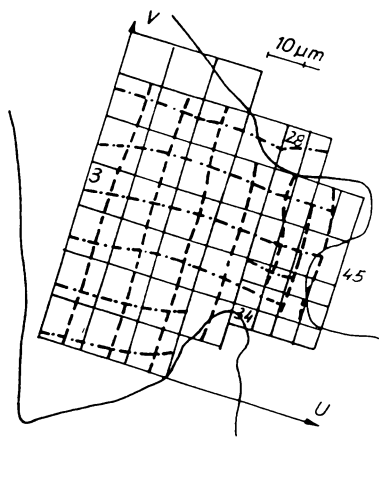
Fig. 5. Exemplary distribution of isthmus displacements U and V with the loading of upper and lower articular processus and of ILL= 6.8 for extension.

The analysis was made by means of the point method with the use of the above mentioned dependences.

Based on the calculations the diagrams of changes of the component deformations U and V of the selected points of the isthmus were plotted. The exemplary diagrams of the deformation distributions are presented in Figs. 5 and 6. For the selected points of the isthmus, i.e. 28, 34, 3 and 45 an analysis was carried out of the changes of component deformations U and V during the selected movement activities of vertebral column, i.e. neural flexion bend and extension positions.

The above given results make us belive that the research method developed for the first time will make it possible to fully estimate the vertebral arch deformation with complex loading states.

References

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