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MEASUREMENT OF HUMAN HEAD AND NECK MOVEMENT

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Abstract – Whiplash injuries which occur mainly in rear end collision are the most frequent injuries reported in traffic accidents. In the available literature there are various approaches to solving and explaining whiplash movement of head and neck. The M.D.Freeman et al. mention a number of more than 10000 works related generally to phenomenon of whiplash movement of head and neck. Regardless of the fact that the mentioned movement has been the subject of numerous studies and discussions, it is still lacking clarity and research. In this work measurements have been carried out with the aim of determining the kinematics magnitudes of movement. Different movements of head and neck have also been defined, which were considered as being useful in determining the data for the interpretation of whiplash movement of head and neck.

Keywords: measurement of head and neck movement, biomechanical model, anthropodynamic.

1. INTRODUCTION

The description of the human head and neck figure in motion is a very important part of biomechanical analyisis of the complete human motion or some sequences of subject motion.

The dummy is very important in investigation whiplash injury but in our opinion cannot simulate realistically human head and neck movement. Because of that, the characteristic movements that occur with head and neck of subjects hit from the back in traffic accidents has been simulated on volunteers with safe loads.

2. MEASUREMENT METHODS

Three different movements, which were considered as important movement of head and neck, have been defined.

One of that movement which were considered as characteristic movement of head and neck during whiplash is presented in presented in Fig. 1. Another two movement was: circular motion of the head and neck, and motion of the head to one shoulder and to another.

The measuring procedure comprises recording of examined subjects aided by stereophotogrametric method, with the system for multifactor analysis of movement – Elite.

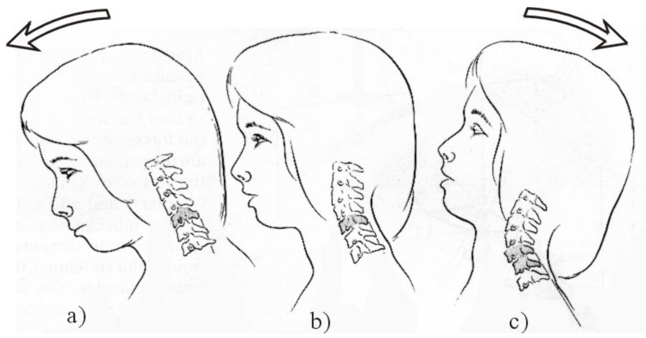

Fig. 1. Example of one characteristically head and neck movement

Based on the shape recognition of passive markers by means of which significant body pinots are marked, Elite performs high accurate analysis of macro and micro movements. The real time TV images processing and the simultaneous acquisition of analogue signals make Elite a very fast system for multifactorial investigation of motion. The software packages are modularly organised. Basic software package is dedicated to the computing of the exact 3D coordinates of each marker. The Elite modelling package allows it to define any model of the body to analyse as a set of points connected by links.

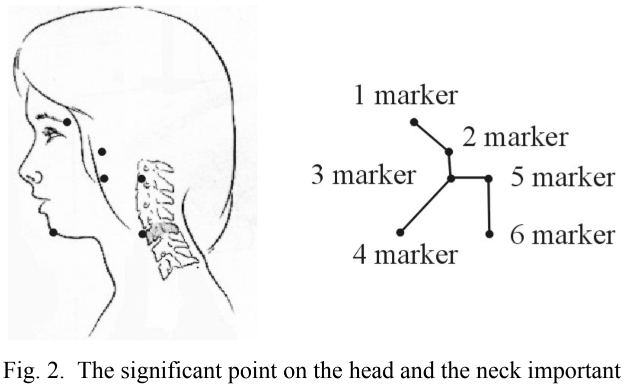

Fig. 2. The significant point on the head and the neck important for movement

The significant points are determined by putting reflective passive skin markers to the subject. The 6 reflective markers were used. In this case, the markers was put on the head and the neck how is shown in Fig. 2.

Two synchronised video cameras of CCD type, equipped by infrared light flashes, have been used for filming purposes, in which is marker coordinates collecting. Sampling rate was 50 Hz. As a filtering procedure signal analysis Lambda method with automatic bandwidth selection via signal power spectrum density has been used.

50 examinees took part in the research, and according to their own opinion had had no previous damage of the cervical vertebra. 30 examinees was male, in age from 20 to 37, and 20 examinees was female in age from 22 to 34. Also, for every recorded subject the basic antropo-measures (height and weight) have been determined as presented in Table 1.

TABLE I. The basic anthropometrics characteristic of examinee

Gender	No.of subject	Height [cm]			Weight [N]		
		$\bar{x}$	min.	max.	$\bar{x}$	min.	max.
female	20	169.5	165	173	622	540	700
male	30	181.8	167	190	787	630	1000

The human head and neck biomechanical characteristics, as the for example moments of inertia, are very important in the description in the human motion of this body part. Because of that, segments' inertial parameters have been calculated using the regression method established by Donskij and Zatscijorskij. This method is extended by suggestions of Muftić, Keros and Božićević.

The masses were calculated by mean of the regression formula:

$$m_{\mathrm{i}} = B_0 + B_1\, M + B_2\, h\,, \qquad (1)$$

where the B_0, B_1 and B_2 are the regression factors calculated by statistical method, M is the total mass of the body, h is the standing height of the individual subject in cm and m_i is analysed segmental mass. Also, the harmonic antrhorpometry procedure is described by Muftić.

Using that results the harmonic model of head and a part of the neck have been defined. The mentioned model represents the human head and neck, which is dividing into a segment of elliptical cylinder, ellipsoid and spherical cylinder. This model was assumed to be predominantly an independent kinetic unit regardless of the fact that it actually represents a kinemtaic unit together with the body. The reason for this lies in the fact that in the dynamic sense the resistance to the rotation of the head on the atlas is significantly less than the overall inertia of head and neck with relation to the co-ordinate system located at the bottom edge of the cervical vertebra.

On the basis of the head and part of the neck model, and the recorded three-dimensional co-ordinates of characteristic points of each movement, kinematic analysis of the recorded movements followed. The analysis was used to determine the orientations and locations of the model segment centres, trajectories of the mass centres of the head and part of neck, which participate in the movement, as well as changes of central dynamic inertia moment regarding the selected co-ordinate system.

Some of the final measuring results are shown in Fig. 3 and Fig. 4. Trajectories of significant body points projected on the sagittal plane are shown in Fig. 3.

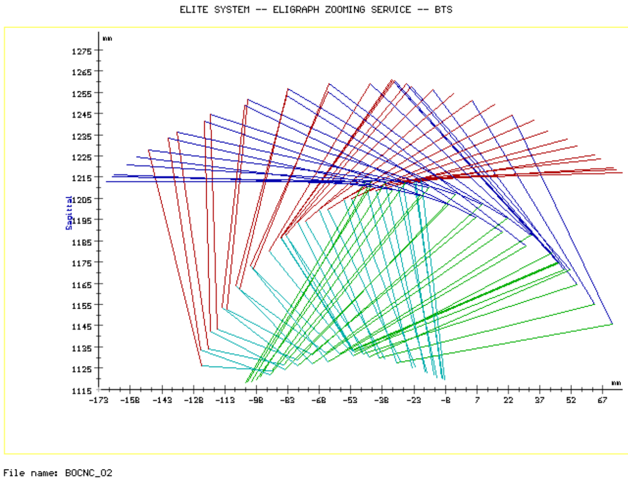

Fig. 3. Trajectories of significant body points projected on the sagittal plane

Component y of the significant body point trajectories is shown in Fig. 4.

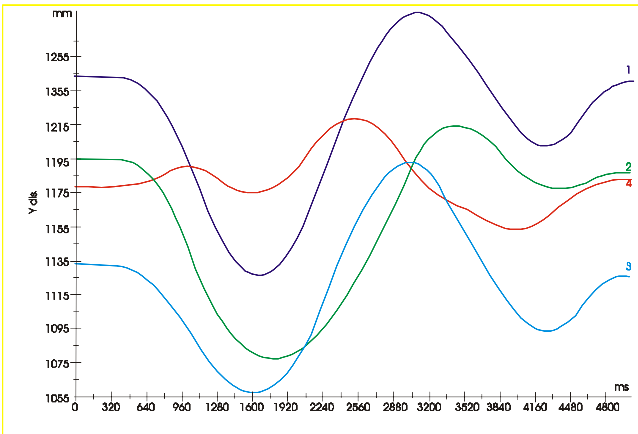

Fig. 4. Component y of the significant body points trajectories

3. CONCLUSIONS

It was determined that by studying the plane movement of head and neck made of translation and rotation, first the rotation of the head around the first cervical vertebra – atlas is significantly pronounced. The determined results allow comparison between mechanical values obtained by measurements on subjects whose movements of head and neck may be considered as "normal" and the movements produced by subjects with damaged cervical vertebra.

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