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ERGONOMICAL STUDY REGARDING WORKING IN SEATING POSTURES OF THE DENTISTS

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Abstract: *The purpose of this paper is to provide a model of the human body for the observation of the advantages of different seated working postures and to validate the simulation results with a thermo graphic experiment, determining the optimal seated working posture. The study was conducted using experimental data taken from dental physicians working in 5 different seated postures. The model proved to be viable and offered a validation of the previous experimental conclusions and also the thermo graphic experiment.*
Key words: *human model, activity, postures, ergonomics*

1. INTRODUCTION

The posture is the human body behaviour in relation with the environment in which he lives, and in relation with the laws that governs these environment, first of all the force of gravity. To do this, man has developed a specialized structure to overcome gravity, called the tonic postural system of vertical stability.

The sitting position is where most of us get into trouble with poor postural habits. This is especially true when driving or using a computer. As we focus on the activity in front of us we tend to protrude the head and neck forward. Because the body follows the head, the thoracic and lumbar spine tends to round forward as well. When this occurs, the weight of the head and upper body is no longer balanced over the spinal column but instead must be supported by increased muscular energy and placing spinal ligaments on stretch. Over time this leads to fatigue and eventually even pain in the neck and upper back.

Sitting with proper postural alignment will allow one to work more efficiently with less fatigue and strain on your body's ligaments and muscles.

Regarding the working environment in the field of the dental physician, most data available on ergonomics is based on observation and on personal experience of the physicians themselves. Most of the work-related physical problems are, in general, only discovered after the harm has already been done and in most cases the need for resting the damaged muscles and tending to the affected part leads to the need of a certain period of less to no activity for the physician. (Hokwerda et al., 2007).

For this study were chosen 5 different seated working postures of the dental physician. The last 2 postures are optimal from ergonomic point of view.

These seated working postures are:
1) Rotate left 70º;
2) Rotate left 70º and bending 25º;
3) Rotate left 45º and bending 25º;
4) Without rotation, bending 30º;
5) Without rotation, bending 45º.

2. GENERATING HUMAN BODY MODEL POSTURES AND PRELEVATION OF DATA

The human body model was generated using the AnyBody Modeling System™ software.

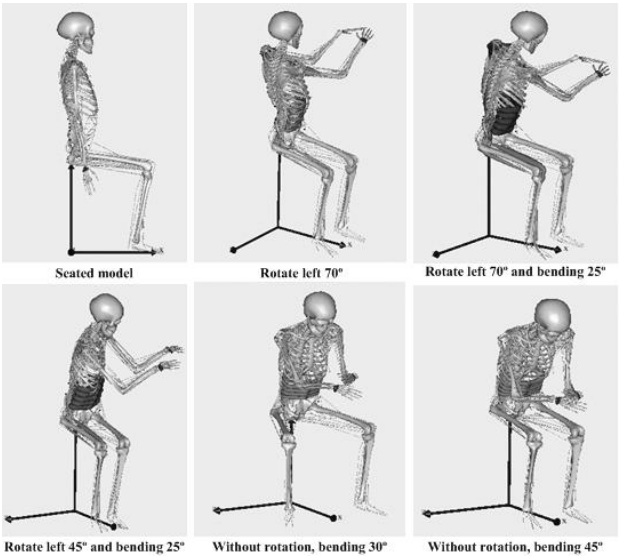

Fig. 1.The human body models in the 5 seated working postures

The body models are available in the standard demo package that can be used in conjunction with the ANYBODY human body simulation software. Starting from a standing human model, using pre-defined muscles and bone attachments, and building the seated working postures scenarios, have been developed.

For the seated position, the chair was added virtually through a node that offers a stabile platform for the pelvis region. The angles for the legs were obtained from an ideal theoretical position for the purpose of minimising their involvement in the general muscle activity of the body system.

All simulated positions have been designed for similar hands and shoulders activity. The overall angle differences for the hands in the eight simulations is minimised so that the general difference in the total muscle activity is given by the other muscles. This allows for a clear view of the influence of the different postures on the system.

All activities include certain tensions in the hands given by an external load. Because of this factor, all models have forces attached to the nodes belonging to each of the hands. This ensures that the data output is similar to that which would be obtained from a real life model and further adds to the accuracy of the model.

All movement patterns were carefully studied for muscle collision and kinematical correctitude; after all data was considered viable, the next phase of the study – using inverse dynamics, was conducted. The data was then extracted from the output of the program for the various muscle groups that were of interest (shoulders and arms, general muscle activity). The most relevant data was considered the shoulders and arms muscle fatigue per cycle investigated. Muscle fatigue (Activity) is defined by the ANYBODY solver as muscle force divided by strength (anybodytech.com, 2007).

3. THERMOGRAPHIC EXPERIMENT

The temperature recorder (thermograph) is an important tool for medical diagnosis because science has managed to prove that all diseases cause temperature changes in a suffering organ. Some types of disorders lower the temperature in that particular organ, others raise it.

The infrared camera we used was FLIR B200 which is based on settings that sense and record on tape the cold and warm areas of the human body by detecting infrared radiations which react to blood flow.

With the help of the infrared camera we took a set of pictures which give the possibility to analyze the body temperature distribution and at the same time the increase of muscle contraction.

The study underwent by keeping a long time, each working posture of the 5 above mentioned, by the dental physician, starting from a resting posture.

The conditions that had to be fulfilled to assure the accuracy of the study were the following:

- Low surrounding temperature, to avoid errors in measuring the real body temperature (the air was renewed, the air conditioner was turned on and the lights were turned off);
- The dentist´s position was maintained for a longer period of time;
- The dentist posed shirtless so that the body temperature could be most accurate.

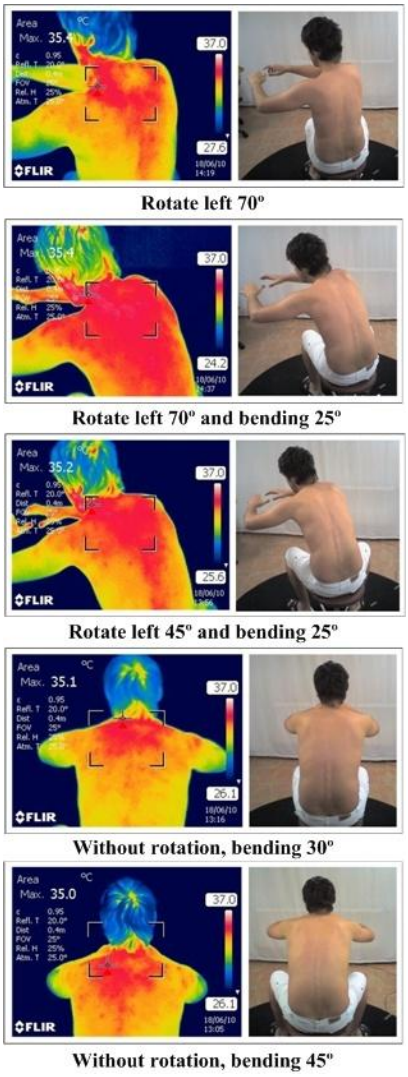

Fig. 2.The thermo graphic images of the arms and shoulders muscle activities

4. CONCLUSION

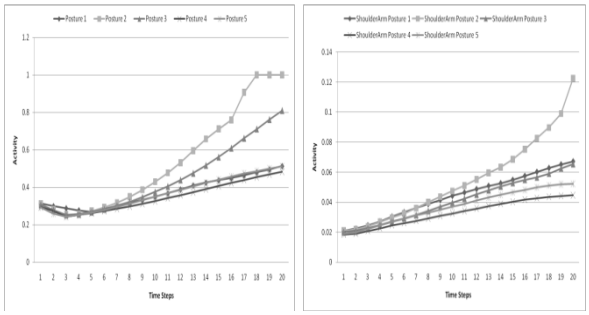

Fig. 3. Muscle activities: total (left), arms and shoulders (right)

After a careful examination of the data and statistical analysis, a clear distinction between the energy consumption for the 5 seated working postures became apparent. According to the results the ergonomic optimal posture is the 4th one. This result is validated also by the thermo graphic experiment by highlighting the temperature distribution. This shows that the posture with the smallest energy consumption and muscle activity is the 4th one (without rotation, bending 30º).

Another aspect of the study is the possibility of pointing out the individual muscle strain for the various shoulder and arm muscles. The impact of such data can lead to improvement of movement ergonomics and development of specific work training that can relieve the tension generated during certain stages of physical activity.

This sort of data obtained from working posture simulations and compared with thermo graphic results, is very useful in ergonomic design of the dental equipment, and also in improving the prevention of the musculoskeletal disorders by using ergonomics.

5. ACKNOWLEDGEMENTS

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