# A NEW APPROACH TO ANALYSING CERVICAL SPINAL MOTION

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## INTRODUCTION

There is a big difference between x-ray-findings of the cervical spine and the actual movements of the patient's head and neck. Fot more information about cervical spine dysfunction a clinical examination is necessary. The problem of defining reduced movement forces requires the specialist to look for objective methods to determine the motion of the cervical spine. Furthermore, the relation of range of motion to age and sex is of great interest, see for example Trott et al., (1996).

Several goniometric methods have been described in the literature (Diihr et al., 1994; Leighton, 1957; Kadir, 1981). Dvorak et al. (1989) described a functional method using computerized images during maximal rotation of the upper cervical joints. They used these to determine the existence of any clinically significant changes between the atlanto-occipital and atlanto-axial joints, after whiplash injuries of the cervical spine.

Our investigations were carried out using a new three-dimensional motion analysis system combined with a computer. Special rigid-body software has been developed to calculate the cervical spine movement in all three coordinate directions (Truesdell, 1965).

As the method offers the opportunity to make accurate non-invasive measurements, we used it to assess the efficacy of one approach to improving spinal motion, the Alexander Technique, which has been shown to improve whole body movements (Stevens et al., 1989).

## METHODS AND RESULTS

A group of 22 normal individuals with an average age of 40 years (range from 22 to 79 years) and 15 patients suffering from cervical spine pain for different reasons (after whiplash injuries, disc diseases or spondylarthrosis normally after sport), with an average age of 46 years (range from 16 to 58 years), have been examined. Another small group of normal subjects were investigated before and after a lesson in the Alexander Technique.

The three-dimensional motion analysis equipment combined with a computer system used was produced by Zebris Gmbh, Isney, Germany. The marker arrangement consisted of a light rigid frame which fitted comfortably on the subject's head. This specially constructed marker frame makes it possible to record the movement of the head with respect to the shoulder. The coordinate measuring system was placed in a defined position to receive the marker data from the seated subject. The method offers good intra- and inter-observer reliability.

The individuals were introduced to the purpose and methods of the survey. Their cervical spine movements were then investigated. The five exercises performed consisted of five repetitions of flexion/extension, axial rotation, lateral flexion, and rotation in both the flexed and extended position. The three angles with respect to the three coordinate axis have been plotted against time (Figure 1). The movement of the head was recorded and the computer program calculated the individual's ranges of motion and the angular velocities in all five movements.

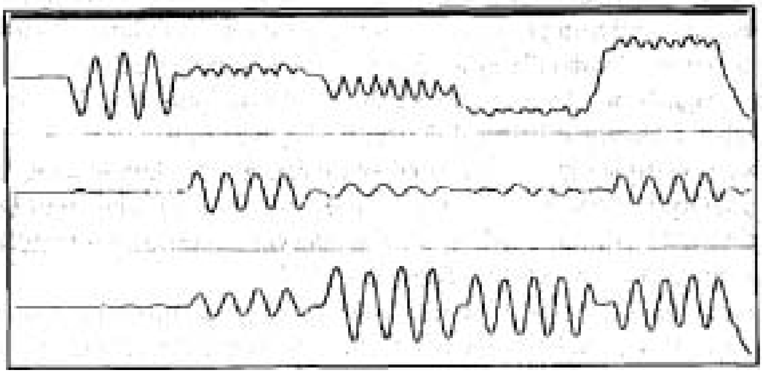

Figure 1. Computer plot of recorded cervical spine angles.

The computer program calculated the relationship between the angle of the cervical spine with respect to the angular velocity in all five exercises. If the motion is a simple harmonic one, the result is a smooth circle. Any deviations from this can be easily observed (Figure 2).

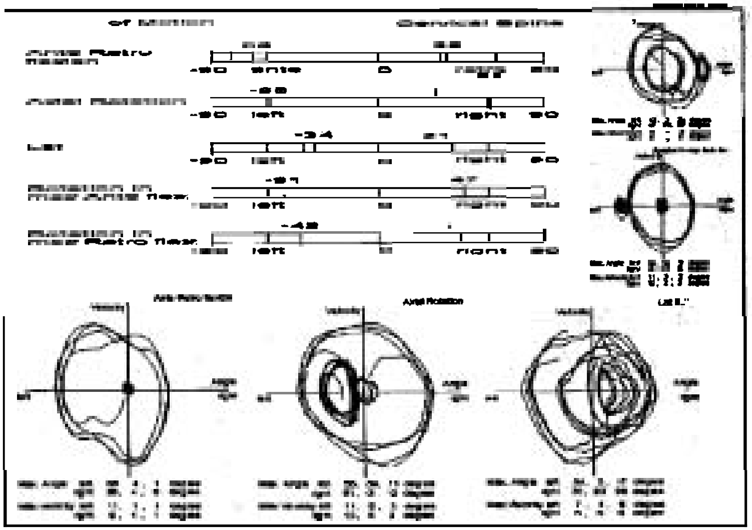

Figure 2. Computer report.

For the group of normal individuals, we found an age related decrease in the range of motion. This is in agreement with the findings of several other authors. We did not find this age related change in the patient's group.

With this measurement system it is also possible to analyse combined and isolated movements in any directions (fig 2.). Due to the kind of combined motion seen with rotation in the neutral, flexed and extended positions it is possible to locate the sites responsible for the reduced range of motion to either the upper cervical spine joints (C0/C1 and C1/C2) or to the lower cervical spine joints (C3 - C8).

We found a remarkable difference in the range of motion between well trained and normal individuals and patients suffering from any cervical spine pain. Additionally, the symmetry of the range of motion was significantly greater for well-trained and normals. The average of the angular velocity during the exercises was significant higher for the normal individuals than for the patients, irrespective of their relative ages.

In the Alexander group there was a decrease in coupled motions, suggesting an increase in the harmonic nature of the motion.

## DISCUSSION

The measurement system and its software enabled the angular data and its time derivative (angular velocity) to be plotted together to form a graph of angle verses angular velocity. From an inverted pendulum model we developed to represent the mechanics of the head and neck, a circular plot would represent an ideal pendulum.

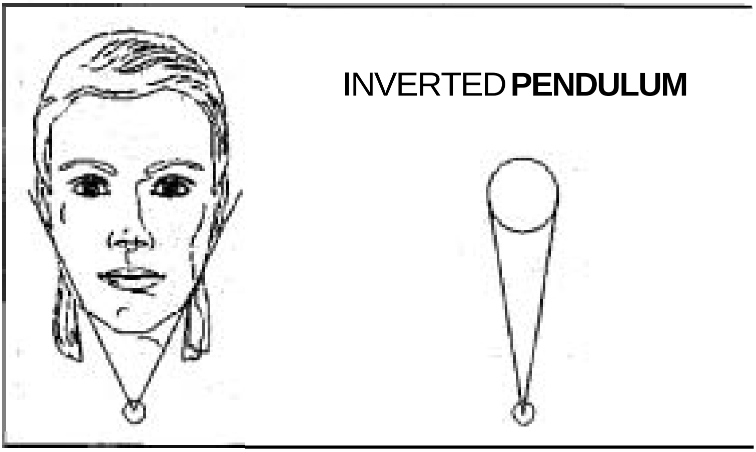


Figure 3. Mathematical Model.

In an ideal inverted pendulum, any disturbances from an upright steady state would be resisted by springs and the pendulum restored to the vertical. Rotations would be restored purely by de-rotations, lateral bending by lateral restoring forces and flexion/extension disturbances by pure flexion/extension righting forces.

Should the model apply to the cervical spine it would give us a useful tool to assess the integrity of the spine, and its passive and active stabilizers. The circularity of the plots is easily assessed and gives us important clues as to the kind of pathology present. One upcoming investigation we plan is to control the EMG of neck muscles prior to the testing detailed earlier.

## CONCLUSIONS

The movement analysis system described allows objective measurements of the decreases in the range of motion, angular velocity and in pain related coupled motions without exposing patients to X-radiation. In the future we plan to extend our investigations to a wider number and range of subjects and to further develop the inverted pendulum model discussed. This may enable a better diagnosis of cervical spinal movements.

The ease and cheapness of the measurements make them suitable for monitoring participants in sport disciplines which seem connected to cervical spine problems for bikers and breaststroke swimmers, as well as water jumpers. It also allows an easier objective assessment of the efficacy of therapeutic interventions.

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