INVESTIGATION OF THE CERVICAL SPINE MOTION

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There exists a big difference between x-ray-findings of the cervical spine and the subjective behaviour of the patients in order to get more information about cervical spine dysfunction for clinical examinations. The objective is to define reduced movement in any direction so that the specialist is provided with an objective method to determine the active range of motion of the cervical spine. Furthermore the relationship of spinal range of motion to age and sex is of great interest. Several goniometric methods have been described in the literature (Dühr et al. 1994, Leighton 1957, Kadir 1981). Dvorak et al. described a functional method using computerized images during maximal rotation of the upper cervical joints to judge about clinical changes between the atlantooccipital and atlantoaxial joints after whip lash injuries of the cervical spine (Dvorak 1989).

The investigation is completed using a new three-dimensional motion-analysis-system combined with a computer-controlled setup. Special rigid-body software has been developed to calculate the cervical spine movement in all three coordinate directions (Truesdell 1965). The method is of sufficient intra- and interobserver repeatability.

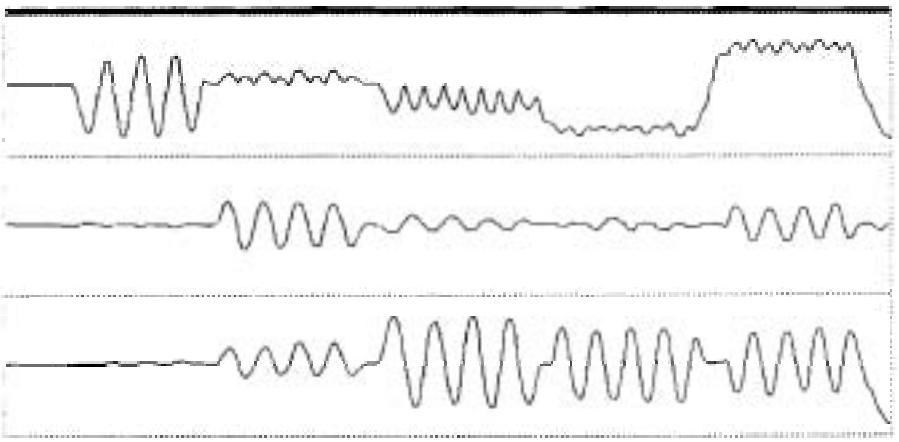

Figure 1: Computer plot of measured cervical spine angles

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 whip lash injuries, disc diseases or spondylarthrosis normally after sport), with an average age of 46 years (range from 16 to 58 years), were examined with the measuring method. The setup consisted of a small frame, no larger than sunglasses. This specially constructed marker frame makes it possible to record the movement of the head with

respect to the shoulder. The coordinate measuring system has been standardized in a defined position relative to a normal sitting position.

The individuals were introduced by one investigator to the purpose and the aim of the survey. They were investigated for all the cervical spine movements. The five exercises consisted of five repetitions of flexion/extension, axial rotation, lateral flexion, rotation in flexed and extended position. The movement of the head was recorded so that the computer program could calculate the individual range of motion and the angular velocity.

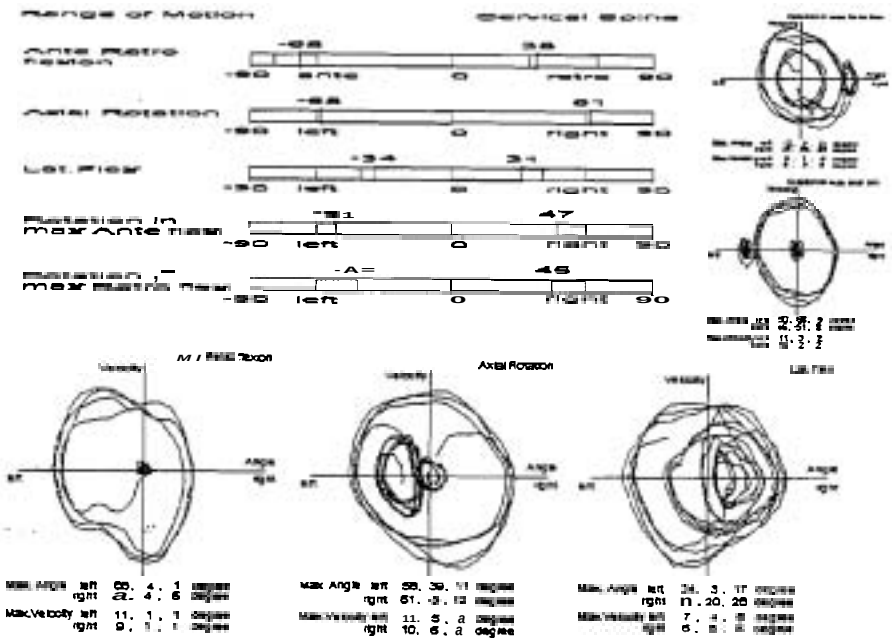

Figure **2:** Computer report

The three angles with respect to the three coordinate axis are plotted relative to time (fig. 1). The computer program calculates a report which shows the angle of the cervical spine with angular velocity for all five exercises (fig. 2). As a result of harmonic movements variations from a smooth circle can easily be realized.

In the group of normal individuals we found an age related decrease in the range of motion as described by several other authors. In the group of patients this dependency could not be found.

With this technique it is also possible, to define combined and isolated movements in any directions and we have been able to relate the reason for reduced range of motion to the upper cervical spine joints (C0/C1 and C1/C2) or to the lower cervical spine joints (C3 - C8). This relationship depended on the kind of combined motion concerned with rotation in neutral, flexed and extended positions.

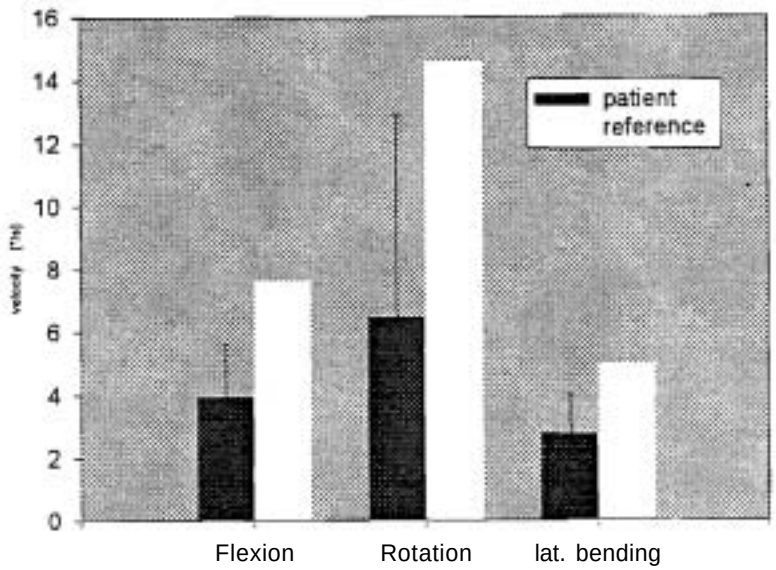

Figure 3: Range of motion (normal vs. patient)

We found a remarkable difference in the range of motion between normal individuals and patients suffering from any cervical spine pain. Additionally the symmetry of range of motion is significant for normal conditions of the cervical spine (fig. 3). The average of the angular velocity during the exercises were significantly higher for the normal individuals than for the patients with no relationship to age (fig. **4).**

The conclusion is that there is now a new method to define cervical spine movement in a very objective way. The setup furthermore is capable of getting results about the amount of decreases in the range of motion, the angular velocity and pain related, coupled motions without any x-ray. Future investigations will be continued using our setup with a more homogeneous group of patients. We are sure that there are possibilities to judge, more exactly, the problems in cervical spine movement. Whip lash injuries seem to be a major problem and there are sorne rare sport disciplines which cause cervical spine problems, eg., bikers, breaststroke swimmers, water jumpers.

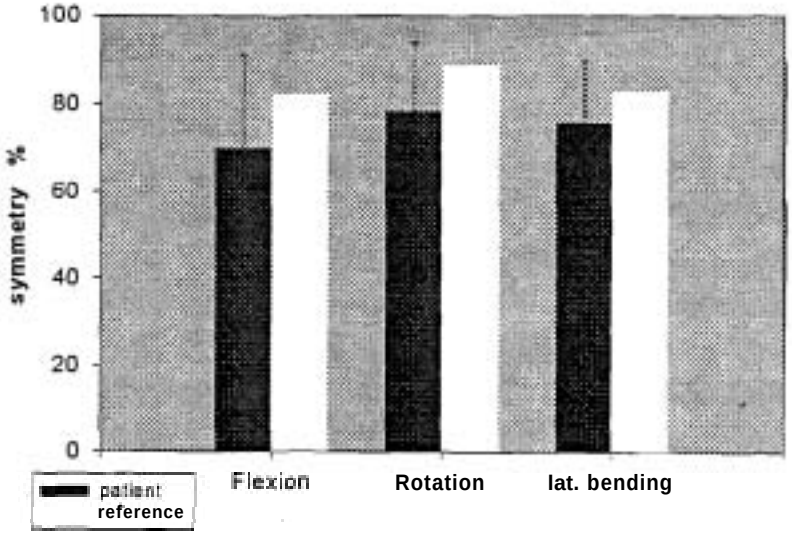

Figure 4: Symmetry of range of motion

For these sports injuries we now have a new method to define cervical spine motion with objective clinical measures beside x-ray or magnetic resonance images (MRI).

[1] Dvorak, A. et al.: Functional evaluation of the spinal cord by magnetic imaging n patients with rheumatoid arthritis and instability of upper cervical spine, Spine 14(10); 1057-1064, 1989.
[2] Dühr, N. et al.: Altersveranderungen der aktiven Beweglichkeit der Halswirbelsäule, Orthop. Praxis 4, 193-197, 1994.
[3] Truesdell, C., W. Noll: The nonlinear field theories of mechanics - Kinematics, in: Handbuch der Physik, von: S. Flügge, Springer, New York, 1965.