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DOES HYPEREXTENSION HAVE AN UNLOADING EFFECT ON THE INTERVERTEBRAL DISC?

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ABSTRACT. A stadiometer (a device to measure the overall height of a subject) was used to determine the effect of hyperextension in rehydration of the intervertebral disc. Hyperextension for 20 minutes in a prone posture was compared with the prone posture alone for 20 minutes. The stadiometer measurement was made after the subject was exposed to 10 kg of loading applied to the shoulders for five minutes and after each of the recovery postures. It was found that hyperextension gave a significantly increased height recovery compared with the prone posture.

Key words: stadiometer, hyperextension, creep, spine.

INTRODUCTION

The basic unit of the spine, the functional spinal unit (FSU), principally consists of two adjacent vertebrae, intervertebral disc and intervertebral ligaments. Functionally, the unit acts as a three-point mechanism with its kinetics and kinematics controlled by the intervertebral disc and the facet joints. Lorenz et al. (22) found that the facets carried 25% of the axial load in the lumbar spine, while Yang & King (36) estimated the load to range from 3 to 25% dependent on orientation. For an arthritic facet the load reached 47%. Recently, Adams et al. (3) showed that the neural arch becomes weight-bearing in extension (lordosis) and can be damaged by compressive loads as low as 500 N.

The intervertebral disc has been reported by Virgin (35), Hirsch & Nachemson (14), Brown et al. (7), Rolander (30), Markolf & Morris (25), Kazarian (15), Kulak et al. (19), Lin et al. (20), Liu & Ray (21), Keller et al. (16), and Wilder et al. (34) to exhibit creep behaviour. These experiments were based on tests of FSU's with the posterior elements intact. The rationale for this was that Tencer et al. (31) found that the load-deformation behaviour at low loads was not markedly affected by the presence of the posterior elements.

Other workers have attempted to attain estimates of creep behaviour *in vivo* by means of a stadiometer. The stadiometer (11) is a means of assessing overall spinal height changes whilst maintaining a certain posture. The original report of *in vivo* height changes was by De Puky (10) but the same measurement has been utilized by Boocock et al. (4, 5), Bridger et al. (6), Eklund & Corlett (12), Helander & Quance (13), Klingenstierna & Pope (17), Reilly et al. (29), Troup et al. (32), and Tyrrell et al. (33). The repeatability of the stadiometry method has been markedly improved recently (12). It has recently been used to assess the effects of various exposures. For example, Corlett et al. (12) used stadiometry to infer that axial loading causes disc creep. Magnusson et al. (24) showed that static sitting caused height loss that increased with age, which was interpreted as an indication of degree of degeneration. Klingenstierna & Pope (17) and Magnusson et al. (23) also found that whole body vibrations caused spinal height loss.

Burton & Tillotsen (8) investigated the effect of overhead work on the spine. It was concluded, on the basis of stature changes, that overhead work did relieve the load on the spine. The increased height was attributed to the hyperextended posture. The finding although not directly and easily explainable will contribute to our understanding of the load-sharing inflicted by the posture and work task. These observations might also be of importance for our understanding of the McKenzie method (26). In this widely used back treatment technique the principle is to have the patient lying prone in extension. The exercise is intended to be progressive up to the "maximum possible extension range". McKenzie does not speculate what the mechanism of therapeutic relief is but infers that the disc nucleus moves

Table 1. *Anthropometric data of the subjects*

Subject (cm)	Age (kg)	Height	Weight	Smoking
M	26	188	93	no
F	29	170	52	no
F	25	160	67	no
F	22	168	67	yes
M	24	188	75	yes
F	29	163	54	no
F	23	173	63	no
F	30	165	52	no
F	28	168	69	no
F	21	172	85	no
M	23	181	69	no
M	34	180	66	no

relative to the annulus and that the stress distribution in the annulus is altered.

Based on the hypothesis that spinal height changes are dependent on the amount of compressive load the aim of this study was to evaluate the effect on loadsharing of the hyperextended posture.

MATERIALS AND METHODS

A version of the stadiometer developed by Eklund & Corlett (11) was modified for use in the seated posture. This technique has previously been validated by Magnusson et al. (27).

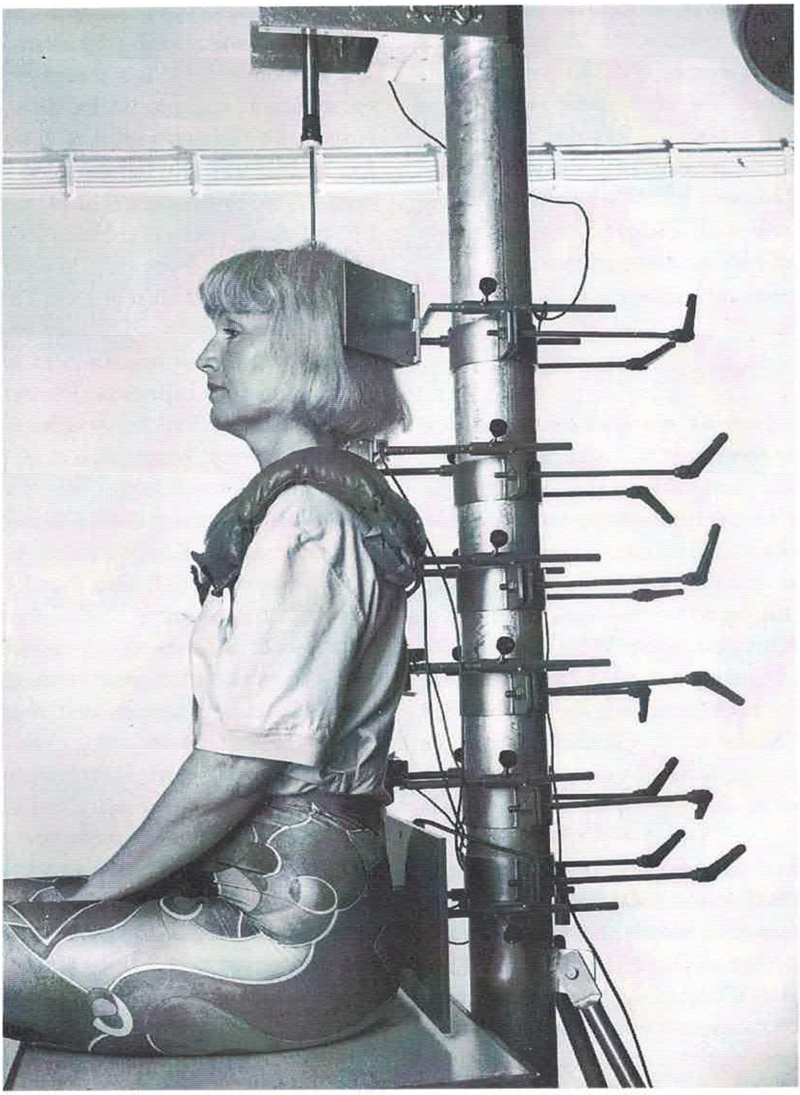

Fig. 1. Subject positioned in the stadiometer during recording of height change.

Table II. *Mean height loss after 6 minutes' loading exposure and mean height gain from 20 minutes' recovery periods*

Subject	Load 6 min	Hyperextension	Prone
1	−8.99	+10.07	+7.76
2	−11.47	+12.21	+11.55
3	−7.18	+9.40	+5.12
4	−6.26	+5.27	+6.82
5	−6.08	+5.44	+5.92
6	−5.78	+7.31	+5.95
7	−7.04	+4.76	+6.97
8	−9.40	+13.53	+8.25
9	−8.97	+9.9	+8.42
10	−10.30	+14.85	+10.73
11	−3.03	+3.8	+2.64
12	−4.42	+5.78	+3.63

The subjects were four males and eight females with ages ranging from 21 to 34 (mean 26.3). All were free of low back pain and other illnesses at the present time. The subject characteristics are shown in Table I.

Initially the subject adopted the seated posture and the posture controls of the stadiometer were set (Fig. 1). LVDT (linear voltage displacement transducer) data were recorded for one minute. The subject then lay down in either the prone or prone hyperextended (Fig. 2) posture for 20 minutes. The move from this position to under the LVDT and final positioning took about 10 seconds. Measurements were made during one minute static sitting followed by additional loading of 10 kg applied on the subject's shoulders for five minutes. The prone and hyperextended postures were randomly assigned four times between the loaded exposures and measurements.

RESULTS

Table II gives the stadiometer readings. All subjects lost height during static sitting and even more under additional load. The mean height loss from 6 minutes' loading was 7.4 mm (+/− 2.5). The average recovery from the prone posture was 94%, whereas the recovery from prone hyperextended posture was 115%. The values given in the table are the means of five exposures for each subject and the means of two recovery sessions in each of prone and prone hyperextended position. Wilcoxon signed ranks test was used and showed a significant difference between the two recovery postures ($p < 0.05$, one-tailed).

DISCUSSION

Eklund & Corlett (11) popularized the use of the stadiometer to estimate the spinal loading by measuring the change in stature induced by work or other tasks. The principle behind the method is that loading the spine will result in disc height loss due to fluid loss and viscoelastic deformation of the intervertebral discs; this strain should be measurable as reduction of stature. Facet loads would seem to be important to stature change but these have not been previously

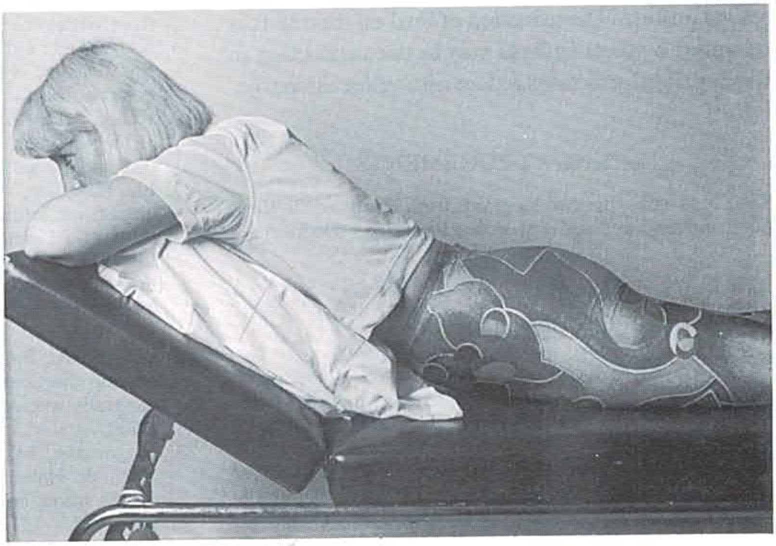

Fig. 2. Subject in the prone hyperextended posture.

taken into account. Some of the compressive load is resisted by the facet joints according to Adams & Hutton (1), Lorenz et al. (22) and Yang & King (36). However, the majority of the load is still carried by the intervertebral discs (2). The facets may provide a more rigid effective fulcrum in hyperextension, allowing tension to be applied to the disc and in such a way allow more fluid to be imbibed, resulting in a rapid increase in height (28). However, facet loads are particularly important in certain postures, judging by the results of this study. We found that hyperextension increased disc height more than prone lying. This should not be taken to mean that there is no spine loading but rather that loads are shifted to the facets. Across subjects there was an average 22% increase in height gain between hyperextension and prone. Taking average anterior disc heights of the lumbar spine from Nissan & Gilad (27) this results in an average height increase over the lumbar spine of 11.6 mm. Backwards bending postures, for instance, are common in work that involves overhead tasks. Burton & Tillotsen (8) have suggested, on the basis of height change measurement, that hyperextension work does not lead to unacceptable spine loads but clearly the postural and muscular loads must be accommodated somewhere and the best candidates are the facets. Although the sample was too small to divide into subgroups for statistical significance it is noteworthy that some of the least height gains were noted in the smoker. There was a trend, again not statistically significant, to less recovery in males.

McKenzie (26) has developed a method that reduces pain in the lower back by the adoption of a hyperextended posture. The reduction of load on the disc that is implied by these findings may be one mechanism in which painful structures reduce nociceptor discharge.

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