Correspondence of biomechanical changes in respect of pain score and psychological status after the standard and enhanced spine stabilisation trainings

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Abstract

Low back pain is one of the leading causes of disability. Exercise therapy is a management strategy that is widely used in low back pain. The aim of our study was to investigate the results of standard and enhanced exercise therapy. 15 patients who had low back pain were involved in the study, none of the patients had had spinal operations before. In the first group the patients did the exercises every day at home. The patients of the second group did the exercises 3 times a week. For the biomechanical measurement we used the Spinal Mouse, a computer associated device, based on electromagnetic impulses. For estimating pain we used the 3D pain questionnaire (West-Haven-Yale Multidimensional Pain Inventory [WHYMPI]).

In the outline analysis there was a significant rise in the capacity ($p<0,05$) of the thoracic spine. By combined analysis of the two groups in the first group the rise of the capacity in the lumbar region after one month was very intensive. Less significant invers ratio was found between the rise in the capacity of the lumbar spine and the percental change of the pain.

The results show, that though the lumbar stability and the fitness level in the more active group is significantly better, it doesn't result in greater decrease of pain.

Keywords: pain score; stabilisation training; biomechanics of the lumbar spine; pyschological status; Spinal Mouse

Introduction

In our research we have investigated the results of standard and enhanced physiotherapy in patients with low back pain. The study was aimed at biomechanical factors, range of motion, psyhological factors and painscale. According to the literature we have suspected, that the different intensity of spinal-stabilization exercises results in improvement of symptoms differently.

Patients and methods

20 patients who had low back pain were involved in the study, none of the patients had had spinal operations before or had symptoms of radiculopathy or any other neurological symptoms. 5 out of the 20 patients were excluded because of noncompliance. The 15 patients, 8 male (mean age 36 ±5,4 years), 7 female (mean age 32,3 ±5,5 years) had morphological disorder (discopathy, disc degeneration, protusion or instability) in one segment only. The morphological disorders were proven by computer tomography or by MRI.

Neurological involvement (lumbar stenosis or compression), systemic disorders, inflammatory disease and obesity (BMI > 31 kg/m^2) were exclusion criteria. The patients were randomised into two subgroups I/a and I/b. Both groups took part in weekly exercise sessions for one month on spinal stabilization, where they learned exercises of increasing difficulty every week. In group I/a (10 patients) they did the exercises every day at home. The patients of group I/b (5 patients, 5 patients sceded from the study) did the exercises 3 times a week. We assessed the patients once a week before and after training.

Measurement and parameters

For the biomechanical measurement we used the Spinal Mouse, a computer associated device, based on electromagnetic impulses. The device senses the deflexion of the levels of the spinal processes as it moves along the spinal column. The data is forwarded by bluetooth to a PC. The measured values are processed by the computer, and based on standardized data, the mesaured data are represented in 2-3 dimension. The position of the vertebrae, the functional shift of the vertebrae, and their relation to each other were evaluated by the Spinal Mouse. The kyphotic angle is marked by +, the lordotic by the – sign *(Figure 1, 2)*.

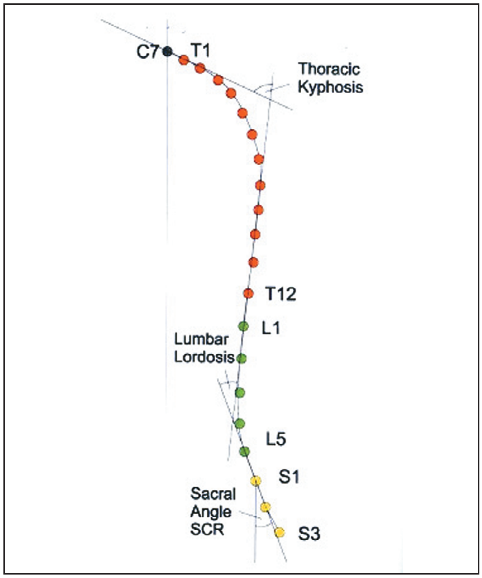

Figure 2. The measurement of thoracic kyphosis and lumbar lordosis

During the study we used the axial endurance test and the Matthias test of the set. The validity parameters of Spinal Mouse *(Figure 3)*.

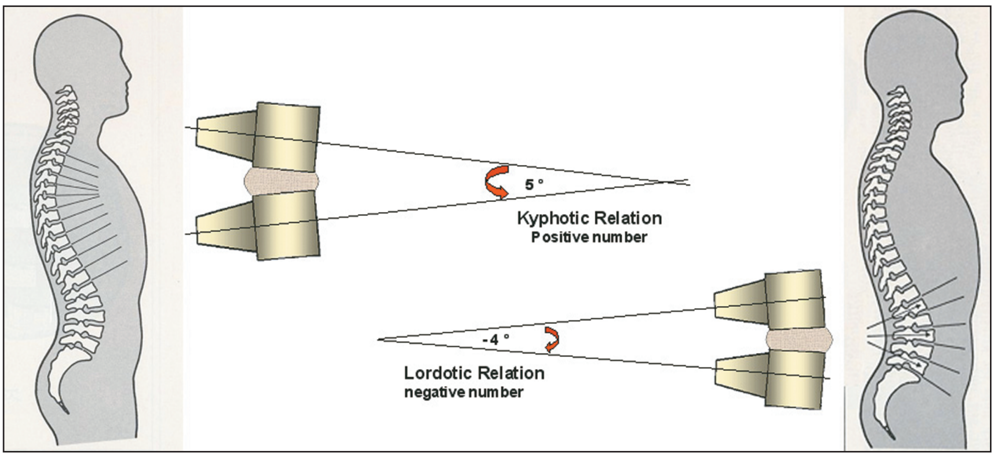

Figure 1. The kyphotic and lordotic angles

Variability (standard deviation SD, n = 50)
(A) = trained (B) = untrained
Systematic (invariant spine shape – laying position)
(A): **SD= +/- 0.8°** (B): **SD= +/- 1.3°**
Intraindividual (repeated upright position after walking)
(A): **SD= +/- 1.3°** (B): **SD= +/- 1.8°**

Intra-rater reproducibility (n = 50)
mean correlation coefficient **r** for segmental angles
(A): **r = 0.97** (B): **r = 0.94**

Inter-rater reproducibility (4 trained raters; 20 healthy probands)
cross-correlation coefficient **r = 0.93**

Comparison with functional radiograph (Th11 to sacrum)
flexion – extension: **r(segm)= 0.84 r(lumb) = 0.95**
upright-flexion: **r(segm)= 0.87 r(lumb) = 0.98**

Figure 3. The variability and reproducibility of the Spinal Mouse

During the study we used the functional test of the set. The validity parameters of Spinal Mouse *(Figure 3)*.

The Spinal Mouse was calibrated by a ZEBRIS ultrasound-based measuring method with WINSPINE software. The accuracy and the reproducibility of the method were appropriate, because the maximum value of intraobserver variation is 0.97 degrees (18.8%), that of interobserver variation is 1.54 degrees (27.1%). The maximum value of the average difference between the angles determined by the two methods is 1.62 degrees (26.6%).

During the measurement we marked the spinous process the C7 vertebra, and the lumbosacral link, we drew a line between these two points, above the spinal processes from C7 to the sacrum. The first measurment was performed with the patient standing in an upright position with his arms down. On the second measurement we gave the patient standard weights, the patient held the dumbbells for 30 seconds, with his arms raised at 90-degrees. We performed the measurement after 30 seconds whilst the patient still held the weight *(Figure 4)*.

The main parameters that we measured were the total thoracic angle [A(Th)] and the total lumbar angle [A(L)], by using expletive angles.

Body weight		Man	Woman
<55 kg	=	2×1,5 kg	2×1,0 kg
56 to 70 kg	=	2×2,0 kg	2×1,5 kg
71 to 85 kg	=	2×2,5 kg	2×2,0 kg
>86 kg	=	2×3,0 kg	2×2,5 kg

Figure 4. Scale of weight

The results were compared with the standardised results of the normal population, which were fixed into the software of Spinal Mouse. This standardised data defines a normal range, we used the limit values and the median value of this range. The axial endurance capacity of the spine is characterized by a change of bend and deviation of the angles, evoked by strain. (M2-M1)

To analyze the changes in time we used the next parameters:

n: deviaton from the normal value (+, –, 0) in degrees
m: deviaton from the median value (+, –, 0) in degrees
th: thoracic spine
l: lumbar spine
DT: the difference between the measurement before (T1) and after (T2) training (T2-T1 +, –, 0) in degrees
b: first measurement
e: last measurement
Dbe: the difference between the first and the last measurement (+, –, 0) in degrees

During the measurement we analyzed the changes of the correction angles during strain (M2-M1). In the first measurement series *(figure)* we assigned the difference of the values between the first and the last measurement Dbe (M2-M1) n,m in the thoracic and the lumbar spine.

In the second measurement series, as the level of taughtness, we defined the balance of the spine stabilizing muscle group from the measured values before and after training DT (M2-M1). We used the difference of the results from the first and last measurements DbeDT (M2-M1) n,m.

Measurement of the pain and psychological involvement, group forming II and III

For estimating pain we used the 3D pain questionnaire (West Haven-Yale [WHYMPI]), and only the part which applied specifically to the pain (I/1, total score: 18) was taken into account. The percental change of the total score demonstrated the amount of improvement.

For the psychological involvement anxiety and depression were measured with the Zung and Spielberger questionnaires, the patients were divided into two groups, the psychologically involved (IIIa) and the not involved (IIIb) group.

Statistical analysis

For the statistical evaluation of groups I. and III. the Kruskal–Wallis one-way analysis of variance was used. We have calculated the H-index from the sum of the Chi-square rank numbers, according to the degrees of freedom of the Chi-square we got the p values.

For the statistical analysis of the pain-scale the Spearman's rank correlation coefficient test was used. After Rho statistical analysis by a permutation test, we got the value of P.

Results

In the outline analysis *(figure)* (2T probe) comparing the mean value (M2-M1) of the first (2.25) and last (–1.5) measurements of the thoracic spine. There was significant rise in the capacity ($p<0{,}05$). In the lumbar region the difference between the average

Patient's code	Group I.a, b	Changes of pain	Psicho-logical status (III.)	Dbe (M1.M2) th,n	Dbe (M1.M2) th,k	Dbe (M1.M2) l,n	Dbe (M1.M2) l,k	DbeDT (M1-M2) th,n	DbeDT (M1-M2) th,n	DbeDT (M1-M2) l,n	DbeDT (M1-M2) l,k
1	1	6	1	0	5	0	0	0	–3	–1	–1
2	1	0	1	–9	–13	0	7	–8	–8	0	0
3	1	6	2	14	14	3	3	–8	–8	5	4
4	1	11	2	0	2	2	2	0	–2	–6	–5
5	1	6	1	0	5	1	1	0	–1	–3	0
6	1	11	2	2	2	2	2	–1	–11	0	–2
7	2	6	1	0	2	0	6	–13	–8	–2	3
8	2	33	1	0	–1	0	–3	–6	–3	0	1
9	2	11	2	6	6	3	3	–1	–1	0	4
10	1	44	2	–8	–18	6	6	–4	–3	–1	–1
11	2	11	1	0	–5	1	1	0	2	4	4
12	2	17	2	0	–2	1	1	No data	No data	No data	No data
13	1	28	1	0	3	0	1	0	–1	–4	–5
14	1	33	2	–2	–8	–2	–5	–2	–5	–2	–2
15	1	No data	1	11	11	0	0	7	4	–3	–5
16	1	No data	1	–6	–6	0	–2	6	7	0	0

Figure 5. Measured values

value (M2-M1) of the first (2.06) and the last (–0.06) measurement is not significant (p-value = 0.14).

We performed combined analysis of the two groups Ia (daily exercise) and Ib (training 3 times in a week). In the group Ia, the rise of the capacity in the lumbar region after one month was very intensive [DbeDT (M2-M1)m]; (H = 6.3112, df = 1, p-value = 0.01200).

Less significant invers ratio was found between the rise in capacity of the lumbar spine [Dbe(M2-M1)n] and the percental change of pain WHYMPI: I/1. The results seem to be on threshold limit of significancy (Spearman's rank correlation rho –0.3391144, p-value=0.1285).

Summary

The results show, that though the lumbar stability and the fitness level in the more active group is significantly better, it does not influence the improvement of the pain. There is a correlation between the stability of the lumbar spine and the level of pain, but there is no significant difference in the improvement between the two groups who had different intensity exercises. The psychologic factor also didn't have significant impact.

In the long term, the daily exercises seems to have been more effective than exercises 3 times a week, although the patients did improve similarly in the short term.

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