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Quantification of spinal configuration and postural capacity for evaluation of different muscle strengthening programs in the therapy of back pain

Dalichau S

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Background

1. The systematic and controlled strength training of the trunk muscles as well as the muscles surrounding the adjoining extremity joints is nowadays regarded as an established form of treatment in the therapy of chronic spinal complaints.

In this context, numerous studies have already been able to prove the level of strength and to reduce the symptomatology of back pain irrespective of the training method used.

However, there is an obvious lack of information regarding a direct comparison of the effectiveness of different strength training methods for the treatment of chronic back pain.

Background

2. In addition, objective quality controls for the assessment of rehabilitative interventions are demanded in order to document the effectiveness of therapeutic strategies and to make them transparent to the cost-bearer as well as to the patients.
Traditional and innovative treatment concepts can also be tested and optimized.

Aim of the study

The aim of this controlled comparative study was to evaluate the effects of three different muscle strengthening programs accepted in the prevention and rehabilitation of spinal complaints.

Material and Methods

- 102 male longshoremen
 - 29 to 63 years (44.4 ± 6.2)
 - chronic back pain since > 2 years
 - ability to work
- matched by pain intensity and functional restrictions
- randomized to 3 test groups (TG) and 1 control group (CG)

Material and Methods

test group 1 (n=25)	test group 2 (n=27)	test group 3 (n=25)	waiting control group (n=25)
training over a period of 6 months two training units each 60 to 90 min. weekly			no treatment (training after completion of the total intervention)
individual medical functional training by means of physiotherapeutic techniques	muscle strength training on devices in a fitness center (3 to 5 bouts, 8 to 25 reps with 50 to 80 % of 1 REM)	spinal gymnastic program for stabilization and mobilization as group therapy	

Material and Methods

Assessments used at the beginning (T1) and at the end of the intervention after 6 months (T2):

- Intensity of low back pain by means of the Visual Analogue Scale (VAS: „0“ (no pain) to „10“ pts. (maximum pain))
- Functional restrictions in activities of daily living by means of the Oswestry Low back pain Disability Questionnaire (OLDQ: „0“ to „100“ %)
- Recording spinal configuration (1) and postural capacity (2) as well by means of the non-invasive ultrasound topometry

Material and Methods

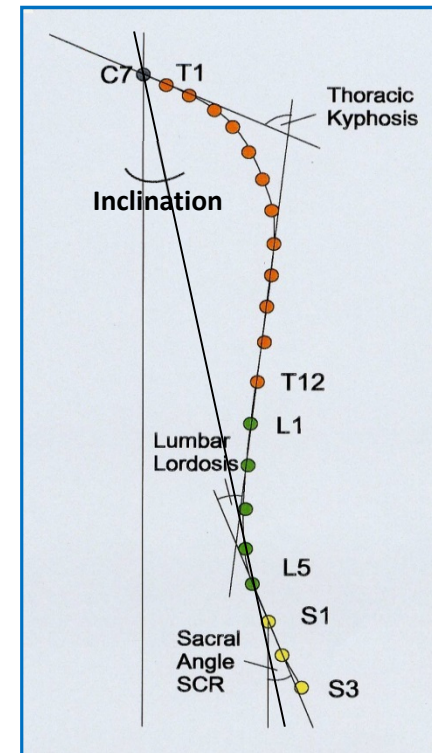
Determination of spinal configuration and postural capacity



The investigator palpates the spinous process line from C7 to S1 with the contact rod sending ultrasound impulses to the measuring receiver.

The reference marker on the right buttock is used for compensation the physiological somato-oscillations.

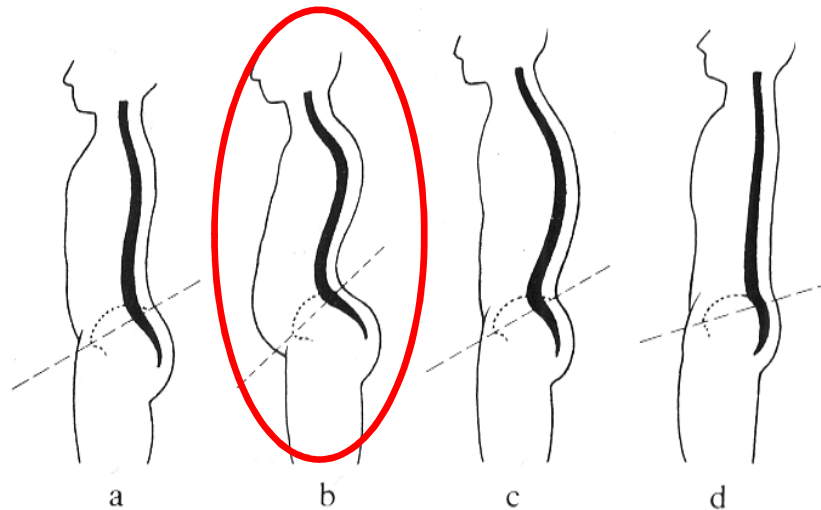
CMS 70P (Fa. Zebris)
Relative measuring accuracy: $\pm 0.5^\circ$
Measurement resolution: 0.1 mm
Measurement rate: 10 Hz.



The spinal profile in the sagittal plane was recorded by analyzing spatial coordinates (triangulation) and enables the determination of the *Thoracic Kyphosis*, the *Lumbar Lordosis* and the *Inclination* respectively *Reclination*.

Material and Methods

Determination of spinal configuration



Taking into account the observation that most adults have a *reversible* slack posture in the sagittal plane during the two-sided upright standing a decrease in the extent of both the thoracic kyphosis and the lumbar lordosis after completing the period of training would indicate an improved posture due to an increase in body tension.

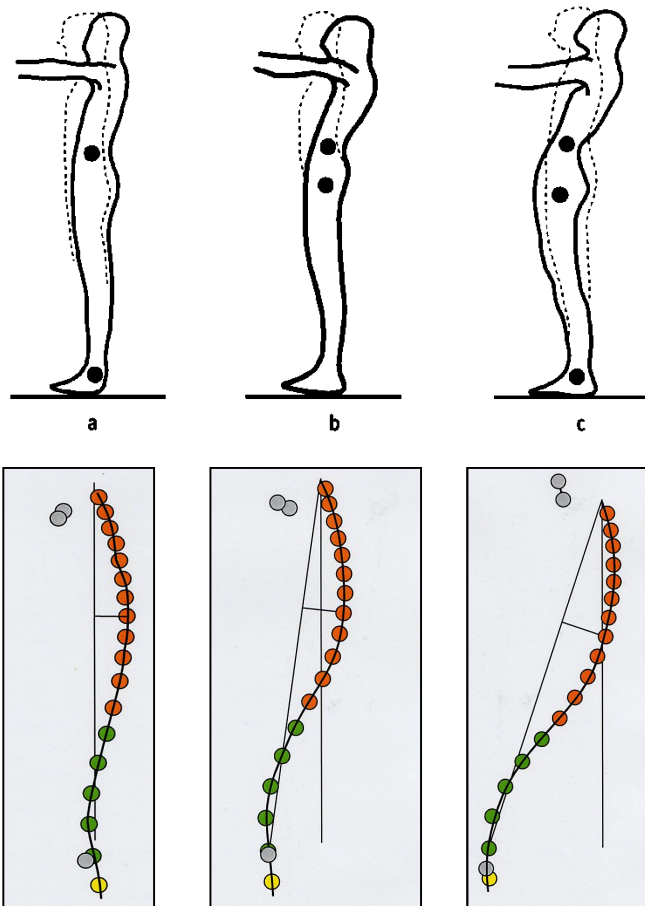
Types of Posture according to Staffel (1889)

modified according to Debrunner (2005):

- a. „normal“ spinal profile while standing upright
- b. hollow round back („slack posture“)
- c. round back
- d. flat back

Material and Methods

Determination of postural capacity by using the arm-raising test according to Matthiass



Arm-raising over 30 sec. with additional load depending on body weight (BW):

BW < 55 kg: 2.5 kg

BW 55-70 kg: 3.75 kg

BW 71-85 kg: 5 kg

BW > 85 kg: 6.25 kg

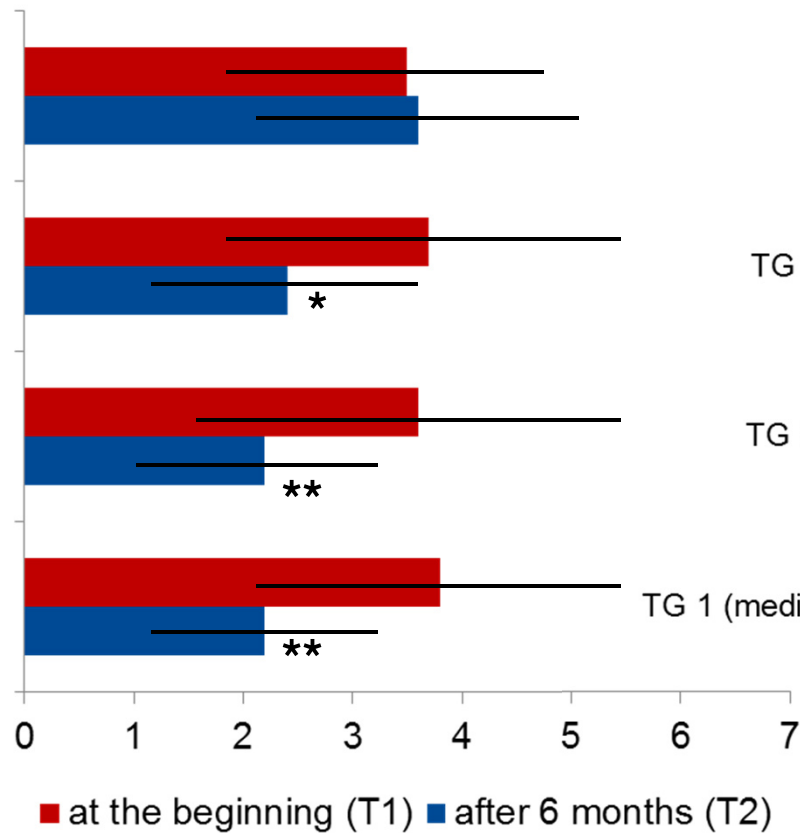
The person with high postural capacity displaces the whole body only slightly backward (a) after arm-raising of 30 sec., sometimes slightly strengthening the thoracic kyphosis and the lumbar lordosis (b). The person who is weak in posture pushes the pelvis forwards, deepens the lordosis considerably, increases the kyphosis and goes into a reclination (c)

Consequently the decrease of the extent of the thoracic kyphosis, the lumbar lordosis as well as the reclination after completion the period of training would indicate an improvement in postural capacity

Results

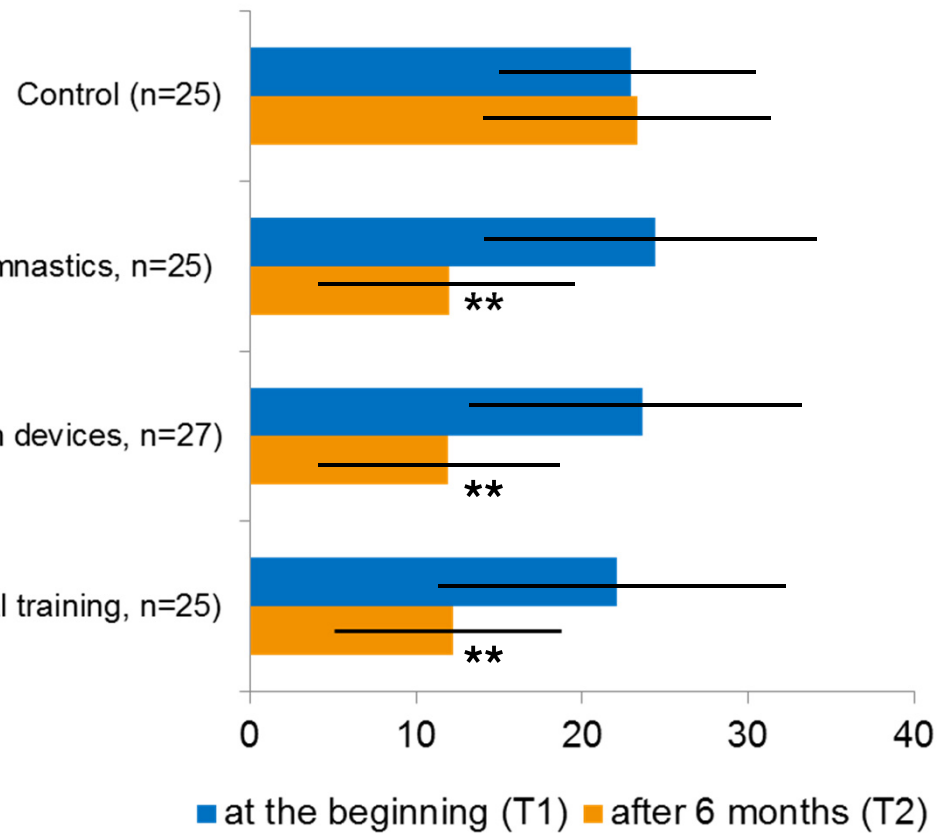
Low back pain intensity

(VAS: 0-10 pts.; means ± SD; *p<.05/**p<.01)



Functional restrictions in activities of daily living

(OLDQ: 0-100 %; means ± SD; *p<.05/**p<.01)



Results

Spinal configuration (upright standing) and postural capacity (after 30 sec. arm-raising) at the beginning (T1) and after 6 months (T2) (means (\pm SD); * $p < .05$ /** $p < .01$)

(°)	TG 1 (medical training)		TG 2 (training on devices)		TG 3 (spinal gymnastics)		Control	
	T1	T2	T1	T2	T1	T2	T1	T2
kyphosis <i>upright standing</i>	46.4 (8.2)	45.1 (6.4)	46.7 (7.9)	43.3** (6.2)	47.2 (9.6)	45.7* (7.5)	46.1 (10.4)	47.0 (11.3)
	53.4 (10.5)	44.2** (7.7)	52.1 (8.2)	42.6** (6.2)	54.8 (8.8)	44.8** (9.8)	52.8 (10.1)	53.4 (9.7)
lordosis <i>upright standing</i>	25.8 (7.3)	25.1 (6.6)	26.2 (7.3)	25.4 (5.2)	26.8 (8.1)	26.2 (5.8)	26.7 (6.9)	27.0 (7.2)
	28.9 (6.1)	26.1** (5.6)	27.6 (5.9)	26.2 (5.9)	28.1 (3.9)	26.4* (4.4)	28.5 (5.7)	28.7 (6.9)
inclination <i>upright standing</i>	3.9 (3.6)	4.0 (2.4)	3.4 (4.7)	3.6 (3.5)	4.4 (4.2)	4.0 (3.7)	4.1 (3.9)	4.5 (5.3)
	-3.8 (2.5)	1.9** (3.2)	-4.4 (3.9)	1.2** (3.4)	-3.2 (2.2)	1.6** (3.4)	-3.2 (2.7)	-2.6 (4.6)

Conclusion

- It can be concluded that all muscle strengthening programs carried out in this study have a positive effect on the back pain situation as well as on the spinal configuration and the postural capacity and can be proven as effective strategies for the treatment of chronic spinal complaints especially with degree of chronicity I.
- However, the improvement of the postural capacity of the subjects in the three test groups can not be explained solely by an increase of the trunk muscle strength, because the main focus of the programs differed a priori. So the device-assisted training focused on the muscle strength of individual muscles, while the spinal gymnastics concentrated on whole body exercises.

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- It is to be assumed that the postural capacity, in addition to the strength of individual muscles, is constituted especially by kinesthetic elements. An improvement of the function of the mechanoreceptors in connection with the knowledge of the subjects about the importance and the execution of an upright body position induce probably a more conscious body awareness and sensitization and can result in an improvement of postural capacity.
- Further studies will be necessary in the future.

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