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Comparative study of muscle energy technique, craniosacral therapy, and sensorimotor training effects on postural control in patients with nonspecific chronic low back pain

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Abstract

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Introduction

Malalignment in the pelvic and spinal column regions exists in 90–80% of the adult population.[1] Malalignment leads to asymmetry in bones and joints in pelvis, trunk, and limbs and affects the muscles and lower limbs and disturbs the balance and decreases the postural control ability.[2] It is known as an early and significant cause or an exacerbating factor in 50–60% of people suffering from back pain[1] particularly the nonspecific chronic low back pain (NSCLBP) which is the most common form of low back pain.[3]

Treatment techniques such as sensorimotor training have been claimed to be effective in postural control.[4,5] It means that, decrease in proprioceptive sensitivity affects balance and postural control.[6] It was shown that sensorimotor training can improve the proprioceptive sense.[7] Muscle energy technique (MET) is a technique that is used to address muscular tension, pain, and dysfunction of joints and to improve the range of motion (ROM).[8] Craniosacral therapy (CST) is a complementary treatment that is believed to release the tension of the muscles, ligaments, and fascia in the sacral zone.[9]

Although there are studies that evaluated the effect of SMT methods on correction of malalignment and postural control in NSCLBP patients, yet no study compared the effect of all these three methods. Therefore, the aim of the present study was to compare the effectiveness of MET, CST, and CST on postural control in patients with NSCLBP.

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Materials and Methods

Subjects

This is a randomized clinical trial study. Forty-five NSCLBP patients who were referred to the physiotherapy clinic of the School of Rehabilitation of Iran University of Medical Sciences, Iran were

selected for this study. A convenience sampling method was used to select the participants. The ethics committee of Iran University of Medical Sciences has approved the study (IR.IUMS.REC139509211342216). All participants signed written consent. The inclusion criteria included patients suffering from anterior or posterior rotation of the right or left innominate or sacroiliac joint upslip, aged between 20 to 40 years, having low back pain (LBP) below the costal margin and above the inferior gluteal folds, and suffering from low back pain for more than 6 months while the exclusion criteria included pregnancy, seizure, tumor, history of neurologic disorder, lumbar fracture, and lumbar surgery. The appropriate individuals were accidentally allocated in three groups including CST (n = 15), MET (n = 15), and SMT (n = 15).

Before starting the first session of treatment the parameters of the center of pressure (COP) including standard deviation COP amplitude in frontal plane (SD-Ax), standard deviation COP amplitude in sagittal plane (SD-Ay), standard deviation velocity of COP in frontal plane (SD-Vx), standard deviation velocity of COP in sagital plane (SD-Vy), anterior-posterior phase plane portrait (PPP-AP), mediolateral phase plane portrait (PPP-ML), anterior-posterior mediolateral phase plane portrait (PPP-APML), mean total velocity (MTV), and area were measured in 8 positions including standing on two legs with open eyes (STLOE), standing on two legs with closed eyes (STLCE), standing on single leg with open eyes (SSLOE) (the dysfunction side leg), standing on single leg with closed eyes (SSLCE), half squat on two legs with open eyes (HSTLOE), half squat on two legs with closed eyes (HSTLCE), half squat on single leg with open eyes (HSSLOE), and half squat on single leg with closed eyes (HSSLCE) were measured. Force plate (Model 9260AA6, Kistler Company, Switzerland) was used to measure the parameters. The signals were collected at a sampling frequency of 100 Hz. Patients were placed on a force plate with bare feet. The distance of the legs during the test was the same as per the width of the pelvis to avoid the effect of the variation on the base of support. Hands were also attached to the body. The blindfold was also made to close the eyes while measuring the desired parameters on the force plate. The reliability of the COP parameters was confirmed through Salavati, Mazaheri, and Moghadam studies.[10,11,12,13]

Intervention

The CST, MET, and SMT interventions were done as follow:

For craniosacral therapy modified protocol by Upledger and Vredevoogd was used.[14] About 10 sessions of CST were performed for the CST group for 5 weeks, i.e., 2 sessions per week. Each CST session comprised of four phases, namely, in prone position, in side-lying position in front of the therapist, in side-lying position behind the therapist, and in supine position. In this treatment protocol, the therapist did not personally modify the patient's CRI (cranial rhythmic impulse) rhythm but only followed and monitored it by releasing and relaxing his mind and paying close attention to the patient's rhythm. Later, after the rhythm of the area was corrected, she moved her hand and again observed the rhythm of the new area carefully. In this way, the erroneous and defective rhythm of the cranial sutures were corrected by the careful attention of the therapist. That is, without any intervention and resistance of the therapist's mind, these positive changes in rhythm occurred.

MET group received 10 sessions of muscle energy technique during 5 weeks; 2 sessions per week were conducted for treatment of posterior rotation of the right or left innominate (to restore anterior rotation) and anterior rotation of the right or left innominate (to restore posterior rotation) dysfunctions (with regard to the dysfunction side)[15] and correction of a sacroiliac joint upslip.[1]

Patients in the SMT group received 10 sessions of sensorimotor training during 5 weeks; 2 sessions per week, according to a global approach by page. Base on this method, patients' improvement was assessed through three phases; static, dynamic, and functional.[16] In each phase, patients experience different postures and bases of support and their center of gravity was challenged.

After the last session of treatment and after 2 months follow-up, all the parameters of COP were measured in 8 positions again.

Statistical analysis

SPSS software (version 22) was used for analyzing data. ANOVA and Tukey post-hoc tests were used to compare the data. Repeated measures of analysis of variance (ANOVA, Wilks' Lambda test) were used to assess the effects of group, time, and interaction. $P < 0.05$ was considered significant.

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Results

The result of repeated measurement of ANOVA in determination of the interactions between SD-Ax and time showed that the pattern of recovery in the three groups (SMT, MET, and CST) does not differ significantly in STLOE ($P = 0.538$), STLCE ($P = 0.988$), SSLOE ($P = 0.213$), SSLCE ($P = 0.177$), HSTLOE ($P = 0.139$), HSSLOE ($P = 0.052$), and HSSLCE ($P = 0.492$) positions.

The result of repeated measurement of ANOVA test in determination of the interactions between SD-Ax and time and SD-Ay and time showed that the pattern of recovery in the three groups (SMT, MET, and CST) had a significant difference in HSTLCE and SSLCE position respectively ($P = 0.049$) [Table 1].

Table 1

Postural control variables with a significant difference between three methods of the CST, MET, and SMT with regard to the position

Position	Intervention Group	Time (mean±SD)			P			
		Base Time	Post Treatment	Follow-up	P_0	P_1	P_2	P_{12}
				SD-Ax				
HSTLCE	CST	0.0079±0.0033	0.0037±0.0015	0.0021±0.0011	0.001	<0.001	0.015	<0.001

Position	Intervention Group	Time (mean±SD)			P			
		Base Time	Post Treatment	Follow-up	P_0	P_1	P_2	P_{12}
				SD-Ax				
	MET	0.0087±0.0025	0.0061±0.0022	0.0061±0.0022*	0.010	0.017	1.000	0.001
	SMT	0.0103±0.0027	0.0061±0.0011	0.0058±0.0010	<0.001	<0.001	1.000	<0.001
	P	0.083	0.270	0.031				
	Result of Repeated Measurement of ANOVA	Time effect	*P*<0.001	F=59.344	Effect size=0.580			
		Group effect	*P*<0.001	F=18.636	Effect size=0.464			
		Interaction Effect	P=0.049	F=2.710	Effect size=0.112			

Position	Intervention Group	Time (mean±SD)			P			
		Base Time	Post Treatment	Follow-up	P_0	P_1	P_2	P_{12}
		SD-Ax						
		SD-Ay						
SSLCE	CST	0.0237±0.0123	0.0091±0.0022	0.0054±0.0036	0.001	<0.001	0.003	<0.001
	EMT	0.0140±0.0123*	0.0093±0.0022*	0.0096±0.0022*	-	-	-	0.200
	SMT	0.0124±0.0044*	0.0112±0.0027*	0.0115±0.0033*	-	-	-	0.688
	P	0.008	0.005	<0.001				
		Time effect	*P*<0.001	F=18.647	Effect size=0.302			

Position	Intervention Group	Time (mean±SD)			P			
		Base Time	Post Treatment	Follow-up	P_0	P_1	P_2	P_{12}
				SD-Ax				
	Results of repeated measure of ANOVA	Group effect	P=0.374	F=1.007	Effect size=0.045			
		Interaction Effect	*P*<0.001	F=8.105	Effect size=0.274			
HSTLOE	CST	0.0091±0.0042	0.0051±0.0016	0.0045±0.0017	0.010	0.006	1.000	0.001
	EMT	0.0071±0.0029	0.0064±0.0026	0.0065±0.0027	-	-	-	0.735
	SMT	0.0113±0.0055*	0.0043±0.0012*	0.0043±0.0012*	0.001	<0.001	1.000	<0.001
	P	0.043	0.003	<0.003				
		Time effect	*P*<0.001	F=28.082	Effect size=0.395			

Position	Intervention Group	Time (mean±SD)			P			
		Base Time	Post Treatment	Follow-up	P_0	P_1	P_2	P_{12}
				SD-Ax				
	Results of repeated measure of ANOVA	Group effect	P=0.757	F=0.280	Effect size=0.013			
		Interaction Effect	P=0.001	F=5.816	Effect size=0.213			
				SD-Vx				
HSTLOE	CST	0.0247±0.0176	0.0095±0.0037	0.0080±0.0066	0.012	0.015	1.000	0.003
	EMT	0.0404±0.0168	0.0183±0.0116	0.0201±0.0.134	0.004	0.016	1.000	0.001

Position	Intervention Group	Time (mean±SD)			P			
		Base Time	Post Treatment	Follow-up	P_0	P_1	P_2	P_{12}
				SD-Ax				
	SMT	0.0575±0.0211*#	0.0210±0.0093*	0.0208±0.0094*	<0.001	<0.001	1.000	<0.001
	P	<0.001	0.025	0.034				
	Results of repeated measure of ANOVA	Time effect	*P*<0.001	F=48.323		Effect size=0.529		
		Group effect	*P*<0.001	F=29.958		Effect size=0.582		
		Interaction Effect	P=0.026	F=3.106		Effect size=0.126		
HSTLCE	CST	0.0337±0.0199	0.0111±0.0046	0.0072±0.0055	0.001	0.001	0.057	<0.001
	EMT	0.0497±0.0181	0.0264±0.0167	0.0266±0.0149	0.002	0.001	1.000	<0.001

Position	Intervention Group	Time (mean±SD)			P			
		Base Time	Post Treatment	Follow-up	P_0	P_1	P_2	P_{12}
				SD-Ax				
	SMT	0.0620±0.0204*	0.0238±0.0.103	0.0207±0.0068#	<0.001	<0.001	0.993	<0.001
	P	0.001	0.065	0.042				
	Results of repeated measure of ANOVA	Time effect	*P*<0.001	F=75.205		Effect size=0.636		
		Group effect	*P*<0.001	F=18.058		Effect size=0.456		
		Interaction Effect	P=0.044	F=2.558		Effect size=0.106		
HSSLOE	CST	0.0426±0.0197	0.0378±0.0061	0.0320±0.0194	-	-	-	0.239
	EMT	0.0819±0.0377*	0.0356±0.0067*	0.0358±0.0064*	0.001	0.001	1.000	<0.001

Position	Intervention Group	Time (mean±SD)			P			
		Base Time	Post Treatment	Follow-up	P_0	P_1	P_2	P_{12}
				SD-Ax				
	SMT	0.0858±0.0412*	0.0411±0.0071*	0.0406±0.0071*	0.002	0.002	1.000	0.001
	P	0.001	0.001	0.012				
	Results of repeated measure of ANOVA	Time effect	*P*<0.001	F=38.402	Effect size=0.472			
		Group effect	P=0.001	F=8.623	Effect size=0.286			
		Interaction Effect	P=0.003	F=5.834	Effect size=0.213			
				PPP-AP				

Position	Intervention Group	Time (mean±SD)			P			
		Base Time	Post Treatment	Follow-up	P_0	P_1	P_2	P_{12}
		SD-Ax						
SSLOE	CST	0.19357±0.0338	0.1798±0.0196	0.1101±0.0517	0.562	0.001	<0.001	<0.001
	EMT	0.2632±0.1439	0.1670±0.0121*	0.1670±0.0121	0.068	0.052	1.000	0.019
	SMT	0.2623±0.0404	0.1960±0.0140	0.1965±0.0142	<0.001	<0.001	1.000	<0.001
	P	0.048	0.041	0.661				
	Results of repeated measure of ANOVA	Time effect	*P*<0.001	F=28.455	Effect size=0.398			
		Group effect	*P*<0.001	F=12.229	Effect size=0.363			

Position	Intervention Group	Time (mean±SD)			P			
		Base Time	Post Treatment	Follow-up	P_0	P_1	P_2	P_{12}
				SD-Ax				
		Interaction Effect	P=0.039	F=3.264		Effect size=0.132		
SSLCE	CST	0.3668±0.2802	0.2353±0.0389	0.0072±0.0055	0.264	0.022	<0.001	0.013
	EMT	0.2747±0.0923	0.2344±0.0212	0.0266±0.0149 *	-	-	-	0.133
	SMT	0.2792±0.0296	0.2639±0.0297	0.2599±0.0469*	-	-	-	0.345
	P	0.261	0.175	0.004				
	Results of repeated measure of ANOVA	Time effect	P=0.003	F=9.324		Effect size=0.178		
		Group effect	P=0.498	F=0.708		Effect size=0.032		

Position	Intervention Group	Time (mean±SD)			P			
		Base Time	Post Treatment	Follow-up	P_0	P_1	P_2	P_{12}
				SD-Ax				
		Interaction Effect	P=0.009	F=4.831		Effect size=0.183		
HSSLCE	CST	0.2027±0.0420	0.1940±0.0155	0.1713±0.0553	-	-	-	0.124
	EMT	0.2806±0.0632*	0.1881±0.0178*	0.1887±0.0170*	<0.001	<0.001	1.000	<0.001
	SMT	0.2865±0.0667*	0.2020±0.0181*	0.2008±0.0183	0.001	0.001	1.000	<0.001
	P	<0.001	<0.001	0.033				
	Results of repeated measure of ANOVA	Time effect	*P*<0.001	F=42.148		Effect size=0.495		
		Group effect	*P*<0.001	F=11.684		Effect size=0.352		

Position	Intervention Group	Time (mean±SD)			P			
		Base Time	Post Treatment	Follow-up	P_0	P_1	P_2	P_{12}
				SD-Ax				
		Interaction Effect	P=0.002	F=5.620	Effect size=0.207			
				PPP-ML				
SSLCE	CST	0.4195±0.3123	0.1934±0.0267	0.1222±0.0423	0.035	0.007	<0.001	0.004
	EMT	0.2730±0.1561	0.1964±0.0220	0.1986±0.0200*	-	-	-	0.086
	SMT	0.2592±0.0747	0.2140±0.0159	0.2132±0.0210*	0.097	0.138	1.000	0.037

Position	Intervention Group	Time (mean±SD)			P			
		Base Time	Post Treatment	Follow-up	P_0	P_1	P_2	P_{12}
				SD-Ax				
	P	0.071	0.048	0.004				
	Results of repeated measure of ANOVA	Time effect	*P*<0.001	F=16.469	Effect size=0.277			
		Group effect	P=0.646	F=0.442	Effect size=0.020			
		Interaction Effect	P=0.010	F=5.036	Effect size=0.190			
HSSLOE	CST	0.2008±0.0589	0.1583±0.0201	0.1458±0.0246	0.037	0.009	0.183	0.004
	EMT	0.2926±0.1053*	0.1561±0.0271*	0.1552±0.0275	<0.001	0.001	1.000	<0.001
	SMT	0.2827±0.1224	0.1667±0.0103	0.1646±0.0087	0.007	0.006	1.000	0.002

Position	Intervention Group	Time (mean±SD)			P			
		Base Time	Post Treatment	Follow-up	P_0	P_1	P_2	P_{12}
SD-Ax								
	P	0.024	0.024	0.064				
	Results of repeated measure of ANOVA	Time effect	*P*<0.001	F=47.124	Effect size=0.523			
		Group effect	P=0.013	F=4.767	Effect size=0.181			
		Interaction Effect	P=0.037	F=3.401	Effect size=0.137			
PPP-APML								

Position	Intervention Group	Time (mean±SD)			P			
		Base Time	Post Treatment	Follow-up	P_0	P_1	P_2	P_{12}
				SD-Ax				
SSLCE	CST	0.5606±0.4149	0.3050±0.0443	0.1800±0.0851	0.087	0.011	<0.001	0.007
	EMT	0.39049±0.1742	0.3060±0.0288	0.3107±0.0232*	-	-	-	0.092
	SMT	0.3825±0.0724	0.3403±0.0275	0.3367±0.0477*	-	-	-	0.064
	P	0.122	0.080	0.003				
	Results of repeated measure of ANOVA	Time effect	P=0.001	F=13.367	Effect size=0.237			
		Group effect	P=0.852	F=0.160	Effect size=0.007			
		Interaction Effect	P=0.009	F=5.099	Effect size=0.192			

Position	Intervention Group	Time (mean±SD)			P			
		Base Time	Post Treatment	Follow-up	P_0	P_1	P_2	P_{12}
				SD-Ax				
HSSLOE	CST	0.2860±0.0697	0.2507±0.0223	0.2267±0.0534	0.239	0.062	0.292	0.013
	EMT	0.4089±0.1102*	0.2450±0.0276*	0.2449±0.0277*	<0.001	<0.001	1.000	<0.001
	SMT	0.4045±0.1331*	0.2621±0.0179*	0.2598±0.0179	0.002	0.002	1.000	0.001
	P	0.003	0.003	0.029				
	Results of repeated measure of ANOVA	Time effect	*P*<0.001	F=51.626	Effect size=0.546			
		Group effect	P=0.001	F=7.980	Effect size=0.271			

Position	Intervention Group	Time (mean±SD)			P			
		Base Time	Post Treatment	Follow-up	P_0	P_1	P_2	P_{12}
SD-Ax								
		Interaction Effect	P=0.007	F=5.019	Effect size=0.189			
MTV								
SSLCE	CST	0.0015±0.0016	0.0005±0.0001	0.0002±0.0001	0.113	0.024	<0.001	0.014
	EMT	0.0007±0.0004	0.0005±0.00009	0.0005±0.00007*	-	-	-	0.113
	SMT	0.0008±0.0002	0.0007±0.0001	0.0006±0.0001*	-	-	-	0.115

Position	Intervention Group	Time (mean±SD)			P			
		Base Time	Post Treatment	Follow-up	P_0	P_1	P_2	P_{12}
				SD-Ax				
	P	0.074	0.052	0.004				
	Results of repeated measure of ANOVA	Time effect	P=0.002	F=10.129	Effect size=0.191			
		Group effect	P=0.455	F=0.802	Effect size=0.036			
		Interaction Effect	P=0.011	F=4.923	Effect size=0.186			
HSSLOE	CST	0.0004±0.0002	0.0003±0.00006	0.0002±0.001	0.297	0.018	0.018	0.008
	EMT	0.0009±0.0004*	0.0003±0.00006*	0.0003±0.00006*	<0.001	<0.001	1.000	<0.001
	SMT	0.0009±0.0005*	0.0004±0.00005*	0.0004±0.00005	0.003	0.003	1.000	0.001

Position	Intervention Group	Time (mean±SD)			P			
		Base Time	Post Treatment	Follow-up	P_0	P_1	P_2	P_{12}
				SD-Ax				
	P	0.003	0.002	0.025				
	Results of repeated measure of ANOVA	Time effect	*P*<0.001	F=51.626	Effect size=0.546			
		Group effect	P=0.001	F=7.980	Effect size=0.271			
		Interaction Effect	P=0.007	F=5.019	Effect size=0.189			
				Area				

Position	Intervention Group	Time (mean±SD)			P			
		Base Time	Post Treatment	Follow-up	P_0	P_1	P_2	P_{12}
				SD-Ax				
HSTLOE	CST	0.0010±0.0007	0.0003±0.0002	0.0002±0.0002	0.004	0.003	0.883	0.001
	EMT	0.0009±0.0006	0.0005±0.0002	0.0005±0.0003	-	-	-	0.053
	SMT	0.0024±0.0029	0.0004±0.0002#	0.0004±0.0002#	0.051	0.049	1.000	0.016
	P	0.036	0.037	0.039				
	Results of repeated measure of ANOVA	Time effect	*P*<0.001	F=16.352	Effect size=0.276			
		Group effect	P=0.027	F=3.951	Effect size=0.155			
		Interaction Effect	P=0.037	F=3.447	Effect size=0.138			

The result of repeated measurement of ANOVA test in determination of the interactions between SD-Ay and time and SD-Vx and time showed that the pattern of recovery in the three groups (SMT, MET, and CST) had a significant difference in HSTLOE position.

The result of repeated measurement of ANOVA test in determination of the interactions between mean SSLOE and time showed that the pattern of recovery in the three groups (SMT, MET, and CST) had a significant difference in HSTLOE position ($P = 0.039$).

The result of repeated measurement of ANOVA test in determination of the interactions between mean PPP.AP and time and PPP.ML and time showed that the pattern of recovery in the three groups (SMT, MET, and CST) had a significant difference in HSSLOE and SSLCE positions, respectively ($P = 0.002$).

The result of repeated measurement of ANOVA test in determination of the interactions between mean PPP.APML and time and MTV and time showed that the pattern of recovery in the three groups (SMT, MET, and CST) had a significant difference in HSSLOE and SSLCE positions ($P = 0.007$).

The result of repeated measure test showed that the mean of MTV was significantly different at different times (pretreatment, post-treatment, after follow-up) in the CST group but not in MET and SMT groups ($P = 0.014$, $P = 0.113$, and $P = 0.115$ respectively).

The result of repeated measurement of ANOVA test in determination of the interactions between mean area and time showed that the pattern of recovery in the three groups (SMT, MET, and CST) had a significant difference in HSTLOE position ($P = 0.037$). The result of repeated measure test showed that the mean of area was significantly different at different times (pretreatment, post-treatment, after follow-up) in CST and SMT groups but in MET group ($P = 0.001$, $P = 0.016$, and $P = 0.053$). The result of ANOVA test showed that the mean area was significantly different between groups in pretreatment, after treatment, and follow-up times ($P = 0.036$, $P = 0.037$, and $P = 0.039$, respectively) [Table 1].

APX: anterior-posterior amplitude in the axis X; APY: anterior-posterior amplitude in the axis Y; APvX: anterior-posterior velocity in the axis X; APvY: anterior-posterior velocity in the axis Y; SD Ax: standard deviation COP amplitude in frontal plane, SD Ay: standard deviation COP amplitude in sagittal plane, SD Vx: standard deviation velocity of COP in frontal plane, SD Vy standard deviation velocity of COP in sagital plane, PPP AP: anterior posterior phase plane portrait, PPP ML: medio-lateral phase plane portrait, PPP APML: anterior posterior medio-lateral phase plane portrait, MTV: mean total velocity, and area.

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Discussion

The results indicate that all three methods were effective on postural control in NSCLBP patients but CST had an effect on more balanced variables. Moreover, CST was more effective in SSLCE. Another point was that the effect of CST continued on most of the balance variables even after 2 months follow-up.

Duray *et al*. (2018) investigated the effect of proprioceptive exercise on balance control in patients with chronic neck pain. The results of the four-step square test, SSLCE and SSLOE were significantly better after treatment and follow-up.[4] In the study by Paolucci *et al*. the effect of the proprioceptive training on postural control in patients with NSCLBP were assessed and a significant decrease was observed in sway length and the mediolateral sway velocity in those who underwent perceptive rehabilitation, indicating improvement in postural stability for the realignment of the trunk.[5] Similar studies have not been conducted on the effect of CST and MET on balance control as well as the comparison of these three methods, and this study seems to be the first study in this field.

Rectus capitis posterior minor (RCPM) is an important postural muscle that plays a significant role in balance and proprioceptive sense.[17] This muscle has a high compression of muscle spindles, which

expresses its role in controlling the proprioceptive sense. The proprioceptive sense possesses the ability to feel and understand the spatial position of the joint and body movements without using eyes and the special receptors transfer the data of this sense to central nervous system (CNS).[18] The relative effect of the proprioceptive sense and the vestibular system in the absence of the vision system on the balance of individuals in different age groups were studied[19] and all age groups were dependent on the proprioceptive sense to maintain balance.[20] It seems that CST, by removing pressure from this muscle, strengthens the proprioceptive sense and ultimately controls the balance.

CST can change the cerebrospinal fluid and the biomechanical properties of connective tissue around the spinal cord. The presence of a limitation in the normal fascia movement, in any part of the body, provides the potential to disrupt the optimal function of the craniosacral system as well as the boundaries and edges formed by the fascia in the form of dura mater in the body. Therefore, any limitation in the normal motion of a dural fascia can affect the normal functioning of the craniococal system. CST can release the limits around the brain and the spinal cord, and subsequently, restore normal functioning of the body.[21] CST prompts the rectangular, normal, and rhythmic cranial cycles to regulate the muscle tone to create and achieve normal alignment and muscle strength symmetry.[1] CST by normalizing the environment around the brain can improve the self-healing system of the body[9] due to which its effect on balance remains continuous.[22]

CST by freeing up the limitations of the CNS and by removing pressure from the tissues of this section may improve the performance of the cerebrospinal fluid and the interpretation and dissemination of environmental information sent through the proprioceptive receptors of the muscles and joints to the CNS.[21,23] The two other therapies can only improve the quality of the messages sent to the brain by strengthening the proprioceptive system. That is, even though the non-symmetric environmental signals are corrected through MET and SMT and send natural and symmetric messages to higher centers of the central nervous system, which (these systems) are responsible for processing, interpretation and coordination between this information and environmental messages, when(or if) higher nervous centers (CNS) be disturbed and restricted, again, the central sections (I means central tissues) interpret and process these environmental messages incorrectly, and will not be able to communicate and coordinate between them. As a result, after the end of the treatment period, nonsymmetric patterns in muscle strength and tension are created and the treatment process will be discontinuous.

CST seems to be induced by subtle stimulation of the mechanoreceptors in the fascia, especially the receptors of the raffini or the free nerve endings, which can cause changes in the autonomic system and lead to inhibition of sympathetic activity and increased parasympathetic activity. Therefore, due to the existence of a two-way interaction between the activity of the autonomic system and the fascial tonicity,[24,25] one can expect that CST, by regulating the autonomic system and regulating the fascial tonicity, frees up the fascial constraints in all parts of the body.

CST by removing pressure from the muscles and peripheral joints strengthens the proprioceptive sense of these muscles and joints, and thus, proprioceptive receptors send balanced signals to higher motor centers.[26] Moreover, due to removal of pressure from the tissue of the brain and the spinal cord, it improves the function of the tissues of the CNS[27] and makes these centers, as the main areas for interpreting and coordinating environmental information, to ensure better and more accurate reading of the symmetrical and natural messages received from the muscles and joints. This issue will also result in the issuance of more specific and more symmetrical motoring messages to lower environmental sectors. For this reason, muscle patterns are also natural and symmetrical, which can ultimately lead to improvements in balance and postural control.

Thus, CST can finally lead to the normal and symmetrical messages received from the peripheral receptors which can be interpreted and coordinated by the specialized centers of the brain and the spinal cord like the cerebellum, and to symmetric signals send to peripheral muscles and joints. Thus, it seems that

nonsymmetric muscular patterns will be largely corrected. By reducing the imbalance in the strength and tension of these muscles, the parameters of balance and posture control of individuals in all conditions, even in the blind eye, will improve. In other words, even in standing position on a single leg, which is mainly observed, there is a need to rely on proprioceptive receptors signals. Due to the improvement of the proprioceptive system and central processing system, we see improvements in balance and postural control of those who are treated with CST.

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Conclusion

The results of this study showed that all three methods of CST, MET, and SMT are effective in postural control in patients with NSCLBP, although it seems that CST is effective on more balanced factors. CST has a greater effect on balance in SSLCE. It was also found that the effect of CST was continuous after follow up.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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