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Does Weighted Kypho-Orthosis (wko) Reduce Risk of Fall in Women With Osteoporosis?: A Preliminary Study

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Abstract

Background: The aim of the present study was to determine the effects of weighted kyphorthosis on improving dynamic balance tests in women with osteoporosis.

Methods: In this randomized controlled clinical trial, twenty three patients with osteoporosis were included. The patients were assigned into two groups: 1) control group who received 4-week home-based daily exercise program and 2) intervention group (weighted kyphorthosis) who performed exercises and wore weighted kyphorthosis for one hour twice a day. Patients were assessed using computerized balance tests by Balance Master (NeuroCom) (Limits of Stability, Step Quick Turn, Sit to Stand and Walk across tests) before and 4 weeks after start of treatment.

Results: Speed in walk across test was improved significantly in both groups compared to baseline from (77.6±25 cm/s to 91.57±30 cm/s and from 72.60±20cm/s to 88.73±18 cm/s) in intervention and control groups respectively. Improvement in right turn time in step quick turn, end point excursion and mean of excursion parameters of Limits of Stability was more significant in orthosis group in comparison with control group ($P < 0.05$).

Conclusion: Applying WKO together with exercise program improved some computerized balance tests in women with osteoporosis.WKO can be suggested as an effective intervention in postmenopausal women in order to reduce the risk of falling.

Keywords: Osteoporosis; Balance tests; Weighted KyphOrthoris; Posture training support

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Introduction

Osteoporosis is a common disorder characterized by reduced bone mass and by deterioration of the micro architecture of the bone tissues, thereby leading to increased bone fragility. It affects around 55% of the population over the age of 50 years in the United States [1-3]. Among common clinical consequences are back pain [4], hyperkyphosis, limitations of physical functioning and impaired health-related quality of life in osteoporotic patients [4-6]. It is characterized by low bone mass and micro-architectural changes of bone tissue, leading to increase in fracture risk [1,2,7]. Vertebral fractures can occur in spinal osteoporosis and constitute a major public health burden. The incidence of spine fracture can be as high as 20% in postmenopausal women [4]. The weakness of paraspinal extensor muscles in osteoporosis accompanied by repetitive vertebral micro fracture results in hyperkyphosis, in osteoporotic patients [8-10]. Changes in spinal alignment would displace the Center Of Pressure (COP) closer to the limit of stability, thereby making it easier to lose balance, with consequent falls in elderly women with osteoporosis [6]. This postural changes and vertebral fractures can impose physical stress on vertebral bodies leading to acute and chronic back pain [5]. Furthermore, osteoporosis is associated with deficits of gait and balance, all together resulting in an increased risk of falls [7]. Falls among the elderly, especially for those with osteoporosis, are associated with high morbidity and mortality and are responsible for hip fracture and are the sixth cause of death among elderly [11].

There are studies indicating that almost one third of falls followed by detrimental consequences are preventable [12]. Apart from environmental modifications and pharmaceutical and physical rehabilitative measures including muscle reeducation and resistance exercises leading to improvements in static and dynamic posture and balance training are among most precious preventive strategies for reducing the risk of falls and subsequent fractures [13-15].

Assessment of postural control and stability in osteoporotic patients through posturography is a promising and sensitive measurement approach for early detection or pre clinical changes in the postural control system [16].

Previous studies have shown that wearing a spinal orthosis such as osteomed, spinomed and weighted kyphorthosis result in improvements of posture and back extensor strength. Weighted kyphorthosis [WKO] is among the most known orthosis in osteoporotic patients. In 2005, Sinaki indicated the positive effects of WKO together with spinal proprioceptive extension exercise on balance, gait, and risk of fall assessed by computerized dynamic posturography [17].

In our previous work ,wearing WKO accompanied by back extensor strengthening exercises lead to significant improvement in functional balance tests including Functional Reach (FR) and Time up and Go(TUG) tests in WKO group compared to exercise group [18].

The purpose of the present study is to assess the effects of wearing WKO together with spinal exercises on balance via performing computerized dynamic balance tests including Sit to Stand, Walk Across and LOS, by Neurocom tests in women with osteoporosis. These tests, performed by Neurocom device, are dynamic and much more functional and similar to daily activities compared to clinical balance tests used in our previous work. Considering these facts, they can better evaluate the risk of falling in the elderly.

Case Presentation

This study was conducted between during 2013 in Shahid Modarres hospital, Tehran, Iran. The protocol of this clinical trial was approved by Shahid Beheshti University of Medical Sciences, Human Ethics Research Committee. This study was designed as randomized clinical trial.

Patients voluntarily referred to physical medicine and rehabilitation clinic were entered the study. Patients were screened initially by an expert physiatrist to determine whether they met the inclusion criteria.

Inclusion criteria were as follows: Women with osteoporosis diagnosed based on low bone mineral densitometry at spine (T-score of <-2.5), aged between 50-75 years old, thoracic kyphosis angle between 35-55 degree (Cobb's angle of thoracic kyphosis was calculated from lateral radiograph of spine).

The patients with the following criteria were excluded from the study:

The presence of secondary osteoporosis due to metabolic diseases (such thyroid disease, etc) evaluated by clinical laboratory tests, the presence of neuromuscular disorders, vertebral fracture in last 6 months, history of spinal or lower limb surgical interventions including arthroplasty, vertebroplasty or discectomy.

Serum level of Ca, P, alkaline phosphatase, 25 HO vitD3, thyroid function tests, Renal function tests, parathyroid hormone were evaluated in osteoporotic patients. The patients with low level of vitamin D and secondary causes of osteoporosis were treated appropriately but excluded from this study.

Patients who met the above mentioned criteria were assigned to two groups (orthosis (intervention) and control groups). At the same clinic, like intervention group, matched controls of comparable age and weight and height were enrolled in the study as control group.

Randomization and Patients' Enrollment

Simple random sampling was used for this study. All patients included in the study received a number then by using random number table they were allocated to two groups (Control and intervention groups).

Equal allocation between groups was performed. Hence, the patients were classified randomly in control and intervention groups. Random allocation sequence, who enrolled patients to interventions were performed by one physician.

Blinding

The assessors supervised and performed NeuroCom balance tests, as well as the statistician were blinded to the group assignment.

Patients in both groups received medications including 1000 mg calcium carbonate and 400 IU vitamin E daily and sodium alendronate 70 mg weekly.

Patients in both groups were also instructed to have 30 minutes of daily walking.

All Patients were followed via telephone calls to home to get sure that they were sticking to the exercises correctly as prescribed for them.

Control group: No orthosis was prescribed for this group; but patients were taught to perform daily back extensor strengthening exercises at home according to professor Sinaki program in Mayo clinic [19] as follows:

1. In supine position, the patient flexes the knees and then abducts and adducts the shoulders while the elbows are extended and upper limbs are in contact with the floor.

2. In the supine position, the patient flexes the knees and put hands over the head. By contracting abdominal muscles the patient tries to draw the low back to the floor and keep this position for 10seconds.

3. In the prone position, the patient puts a pillow under the lower abdomen and gently raises the head and shoulders from the floor as much as possible and keeps this position for 10 seconds.

4. The patient sits on a chair and puts the hands behind the head. Then he/she moves the elbows behind the head while inhaling. The patient will do the opposite while exhaling.

5. Sitting on a chair, the patient flexes the elbows while keeping the arms near to the trunk and then moves the arms back to reduce thoracic kyphosis.

All of the exercise programs were taught by an experienced physical therapist. Also, an illustrated pamphlet describing each exercise was presented to each participant. A paper with a table was given to each patient and she was asked to specify every day if she would do the exercises and bring it on follow up visits. The patients were called by a physical therapist every week to assess exercise performance and associated problems. After 4 weeks, patients were called to return to hospital for re-evaluations.

Intervention group (Orthosis group)

Patients in this group were taught to perform the same home exercises as control group.

Weighted kyphorthosis was also administered for the patients in this group.

Weighted kyphorthosis (WKO)

Weighted kypho-orthosis is an especially designed orthosis (made by Cybernetics Company) with a harness and a 2-pound pouch, which centers its weight on the posterior of the spine at T10 to L4.

The patients were guided to place the weighted kyphosis orthosis over the thoracic spine and adjust the straps such that the bottom of the pouch is located at the waistline.

Patients were instructed to wear the device when ambulating for one hour a day (30 minutes at the morning and the evening) for 4 weeks. During this 4 week, patients were followed by telephone calls to assure that they were using the orthosis correctly.

An experienced orthotist instructed the patient regarding the proper usage of orthosis.

Measures

Dual X-ray absorptiometery (DXA) was used for measuring bone mineral density of spine or hip. All patients were referred to one imaging center for bone mineral densitometry. Then DXA scan was carried out using the Hologic QDR-4500 machine (Hologic, Waltham, MA) to determine BMD values of the femur and lumbar vertebrae. The accuracy of a DXA, a monthly calibration measurement, according to the manufacturer's instructions, was performed.

Precision was defined as the reproducibility and the ability of densitometric systems to detect changes in BMD over time. Precision error of the machine and the technologist kept below 1 % in the center we referred our patients for bone densitometry.

The cobb's angle of kyphosis was calculated from perpendicular lines drawn on a standard thoracic spine radiograph (lateral view): a line extends through the superior endplate of the vertebral body, marking the beginning of the thoracic curve and the inferior endplate of the vertebral body, marking the end of the thoracic curve.

An experienced radiologist ruled out osteoporotic fractures via assessing associated X- rays.

Dynamic balance tests: The NeuroCom Equitest Long Force Plate (NeuroCom International, Clackamas, Oregon) was used to assess the participants' performance on functional tasks. The Long Force Plate was used to objectively evaluate balance and postural stability under dynamic tests [20]. The Sit to Stand, Walk Across, Step/Quick Turn and Limits of stability were selected from the Functional Limitation Assessment Battery due to their ability to target functional characteristics pertaining to lower body strength, flexibility, and balance. These areas of interest were chosen due to their impact on independent Function. All participants performed each task three times and the mean score was used in the analyses.

Subjects were allowed one practice trial for familiarization with the procedure of the test.

Testing Protocols

Before starting protocol, each participant received a verbal explanation of the protocols.

Sit to stand test (STS): During the measurements subjects were positioned on the platform facing the monitor with barefoot. The starting position before each trial was standardized by placing knees at 90 degree flexion by adjusting foot placement.

Subjects were instructed to stand up as quickly as possible when start sign appeared on the monitor. They were not allowed to use arms or hands to push off their legs or the seated surface. Subjects were asked to remain stationary until the test was completed (< 5 sec after they rose).

The parameters of this test are as follows:

a. Weight transfer (in seconds): time elapsed until the moment of rising,

b. Rising index (percentage of the body weight): is the percentage of weight bearing (% body weight), which is the ratio of the amount of weight borne on both legs to the patient's total body weight during the rising phase.(Amount of force exerted on the platform during the rising phase),

c. Center of gravity (COG) sway velocity (in degrees per second): postural sway velocity during upright posture,

d. Left/right weight symmetry (percentage of body weight): symmetry of the body weight distribution on the lower extremities during the rising phase.

Walk Across (WA): —Participants were positioned in front of a force plate and were instructed to "Go," via an audible prompt. Three gait cycles were completed across the force plate, while outcome measures included Step Width (lateral distance in centimeter), Step Length (longitudinal distance in centimeters), and Step Speed (velocity in centimeters/second)

Step/quick turn (SQT): The patient is instructed to take two forward steps on command, and then quickly turn 180° to either the left or right and return to the starting point.

Limits of stability (LOS): The NeuroCom LOS test required participants to transfer their COG, while standing on stable force plates, toward 8 targets in a sequential clockwise direction spaced at 45° intervals around the body's COG, as represented on a computer monitor. Before testing, subjects were informed that the on-screen COG cursor (i.e., visual biofeedback) moved in response to the movements of their body COG.

During the test, subjects were required to stand with their arms by their sides and to maintain their feet in the standardized foot position. A reference grid superimposed on the force plate allowed for careful monitoring of the feet during the testing procedures. They were instructed to keep their body in a straight line, using their ankle joints at the primary axis of motion and to move toward each target as directly and quickly as possible.

Outcomes include: reaction time, sway velocity, directional control, endpoint excursion and maximum excursion. Endpoint excursion and maximum excursion are calculated as percentages of the subject's theoretical 100% limit of stability that is a function of their height.

The test was repeated three times and the average values of the measurements were documented.

Data analysis: SPSS-18 was used for data analysis. Kolmogorov-smirnov was used for testing normality of variable distribution. Independent T-test and Man whitney tests were conducted to determine if there was a statistically significant change in demographic characteristics between the two groups and improvement in balance tests after therapy. Wilcoxon-signed rank test was conducted to determine the significant change in balance tests within each group after therapy.

Table 1: Demographic characteristics including age, height, weight and body mass indices compared between two groups.

Demographic characteristic	Group	mean±sd	P-value
Height(m)	Control(14)	1.51±4.25	**0.64**
	Intervention(9)	1.5±4.62	
Weight(kg)	Control	62±4.62	**0.63**
	Intervention	67±5	
Age(year)	Intervention	62±5	**0.36**
	Control	66±6	
BMI(Kg/m^2)	Intervention	27.1±1.8	**0.75**
	Control	29.6±1.8	

SD: Standard deviation; Intervention Group; Brace and exercise; Control group; exercise only

Ethics: The patients were enrolled after providing informed consent as approved by the institutional review board of Shahid Beheshti Medical University. The written consent form was signed or fingerprinted by the patient.

Results

The patients' characteristics at the start of study were depicted in Table 1. There were no between-group differences at the baseline in demographic characteristics and dynamic balance variables (Table 1-5).

At the beginning of the study, 132osteoporotic patients (hip and/or spine) were assessed for eligibility to enter the study. From 32 patients with osteoporosis at spine, 26 patients met the inclusion criteria and accepted to participate in the study, and 23 people stayed at the program during the follow up(two persons from orthosis and one person from control group were dropped out of the study due to incomplete exercises and not wearing the orthosis completely) . The results of 23 patients (14 patients in control and 9 patients in Orthosis group) who remained in the study were analyzed. (CONSORT flow chart, Figure 1).

Primary outcomes

Step Quick Turn: As it can be read from the Table 2, there was no statistically significant difference in this test scores between the two groups at the start of study. At the end of study, the parameters of this test didn't change significantly in control group. However, only in intervention group, Rt turn time improved significantly compared to baseline (P=0.02).

Sit to Stand: There was no statistically significant difference in this test scores between the two groups at the start of study. At the end of study, there was no statistically significant improvement in the parameters of this test in both control and intervention group (Table 3).

Walk across: There was no statistically significant difference in this test scores between the two groups at baseline.

In both control and intervention groups, significant improvement in speed was noticed at the end of the study, there was no significant difference between two groups regarding speed improvement (P=0.85)(Table 4).

LOS: There was no statistically significant difference in this test scores between the two groups at baseline.

In intervention group, significant improvement in mean of EPE (P=0.01) and mean of MXE (P=0.00) were noticed after intervention. No significant change was noticed in control group at the end of the study (Table 5).

Table 2: The scores of Step quick turn parameters compared between two groups before and after study.

		Intervention group	Control group	P value
Left turn time	Before Tx After Tx	(N=9)2.48±0.83 (n=9)2.15±0.79	(n=14)2.05±0.68 (n=14)1.96±0.57	0.46 0.03
	P value	0.17	0.56	
Rt turn time	Before Tx After Tx	(n=9)2.3±0.64 (n=9)1.91±0.77	(n=14)1.87±0.63 (n=14)1.64±0.51	0.66 0.09
	P value	0.02	0.1	
Lt turn Sway	Before Tx After Tx	(n=9)55.6±9.25 (n=9)54.14±11.52	(n=14)46.64±8.65 (n=14)18.81±9.06	0.91 0.85
	P value	0.63	0.00	
Rt turn Sway	Before Tx After Tx	(n=9)53.75±9.25 (n=9)51.23±12.85	(n=14)48.9±9.88 (n=14)48.10±12.77	0.43 0.59
	P value		0.79	

Table 3: The scores of sit- to –stand parameters compared between two groups before and after study.

Weight transfer	Before Tx After Tx	(n=9)0.42±0.17 (n=9)0.44±0.19	(n=14)0.76±0.3 (n=14)0.59±0.34	0.27 0.37
	P-value	0.87	0.1	
Body weight Rising index	Before Tx After Tx	(n=9)15.4±6.4 (n=9)16.88±7.07	(n=14)12.6±3.9 (n=14)14.68±4.9	0.14 0.24
	P-value	0.18	0.22	
Weight Symmetry	Before Tx After Tx	(n=9)8.55±4.27 (n=9)10.77±3.8	(n=14)8.5±7.56 (n=14)8.71±5.7	0.01 0.23
	P-value	0.18	0.93	
COG Sway velocity	Before Tx After Tx	(n=9)3.68±0.56 (n=9)3.64±0.66	(n=14)2.9±1.1 (n=14)3.3±1.24	0.08 0.06
	P-value	0.83	0.41	

COG (Center of gravity)

Table 4: The scores of Walk Across parameters compared between two groups before and after study.

		Intervention group	Control group	P value
Step length	Before Tx After Tx	(N=9)53.43±17.54 (n=9)57.11±17.59	(n=14)58.08±9.7 (n=14)62.05±18.04	0.39 0.74
	P value	0.34	0.38	
Step width	Before Tx After Tx	(n=9)15.25±3.16 (n=9)16.01±4.81	(n=14)15.06±5.05 (n=14)15.86±5.76	0.13 0.79
	P value	0.67	0.67	
Speed	Before Tx After Tx	(n=9)77.62±25.38 (n=9)91.57±30.74	(n=14)72.60±20.86 (n=14)88.73±18.81	0.14 0.85
	P value	0.01	0.03	
Step length symmetry	Before Tx After Tx	(n=9)17.55±19.85 (n=9)22±21.73	(n=14)15.32±28.65 (n=14)16.58±30.94	0.32 0.59
	P value	0.64	0.83	

Table 5: The scores of Limits of Stability (LOS) parameters compared between two groups before and after study.

PE Flex	Before Tx After Tx	(n=9)45.62±16.97 (n=9)46.37±18.02	(n=14)50.61±21.47 (n=14)45.23±16.37	0.64 0.37
	P-value	0.91	0.7	
EPE mean	Before Tx After Tx	(n=9)60.81±18.37 (n=9)72.86±20.30	(n=14)73.72±11.27 (n=14)72.86±10.21	0.24 0.24
	P-value	0.01	0.81	
MXE flex	Before Tx After Tx	(n=9)57.75±23.18 (n=9)60.75±14.32	(n=14)60.3±22.61 (n=14)58.46±18.31	0.89 0.23
	P-value	0.7	0.75	
MXE mean	Before Tx After Tx	(n=9)73.38±19.95 (n=9)86.92±23.11	(n=14)85.86±12.2 (n=14)89.15±9.09	0.08 0.06
	P-value	0.00	0.14	

COG (Center of gravity); EPE (End point excursion); MXE (maximum excursion)

Secondary outcomes

Patient's compliance: One patient stopped wearing orthosis in the intervention group after one week due to discomfort. One patient in each control and intervention group didn't perform exercises regularly. Their results excluded from final analysis.

Patient's satisfaction: All patients completed the study were satisfied with the treatment (both orthosis and exercises).

Adverse events: No adverse events were noticed during the study.

Secondary discussion

Based on the results of the present study, improvement in balance was noticed in patients with osteoporosis after wearing weighted kyphorthosis for 4 weeks. According to walk across test, speed improvement was noticed in both groups with no significant between group differences. Right turn time decreased significantly only in WKO group. Two parameters of LOS including the mean of End Point Excursion and Maximal Excursion increased significantly in WKO but not in control group.

Improvement in the above mentioned parameters can be translated as better postural stability in intervention group. Postural stability has been defined as the ability to control the body's COG within a given base of support. The understanding of postural stability control (i.e., balance) is essential for performing activities of daily Living and decrease in fall rate [21].

In practice, the actual LOS of a person may be defined as the distance the patient is willing and able to move without losing balance and taking a step [22]. As with the Functional Reach (FR) test, the LOS test has been shown to provide reliable scores that are predictive of fall risk [22].In our previous work [18] WKO lead to improvement in FR. In essence, LOS should measure similar components of balance as FR. However, Wallmann reports that there is no significant relationship between FR measures and anterior displacement on the LOS test [23].

Decrements in dynamic postural control have been attributed to both age and pathologic changes in parameters associated with movements of the COG. Compared with healthy older adults, osteoporotic patients exhibit smaller voluntary COG excursions, reach maximal lean more slowly, and exhibit less postural control once they have reached maximum lean [22].

The LOS test provides spatial and temporal measures (e.g., movement velocity, maximum excursion, directional control) of COG movements as a person volitionally leans to various positions in space [22]. LOS test measures one aspect of balance utilized in daily life, and is a measure of improvement in balance resulting from rehabilitation. Considering the high efficiency of LOS test in early identification of falls in elderly, high reliability of its parameters, high test-retest reliability while measured by NeuroCom and its ease of execution, it is popular and confident in global measures of balance [21,24].

Previous studies suggested that postural control among individuals with osteoporosis is different from general elderly population. Individuals with osteoporosis are more likely to present higher sway velocities and greater maximum shift of the COG [25].

Azadinia [26] evaluated the effects of two spinal orthoses on balance in the elderly with thoracic Kyphosis. Patients were allocated to two groups (Spinomed orthosis and the posture-training support groups). In both groups, significant changes were observed in the studied balance parameters. Authors concluded that both interventions may improve balance in the elderly in a similar manner.

The ability to transfer from sit to stand (STS) is another most commonly performed tasks of daily living. Accurate control of COG

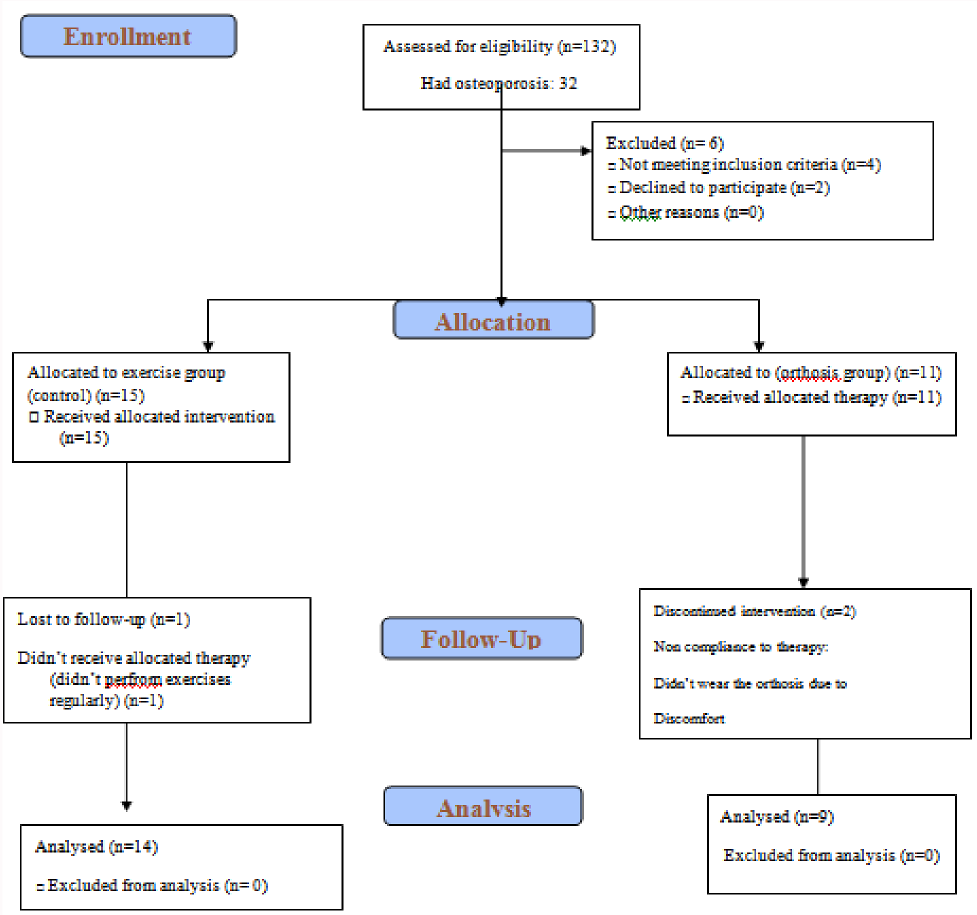

Figure 1: CONSORT 2010 flow diagram.

position is critical in controlling the rise movement, as well as to maintain postural stability. Ideally, COG sway velocity during the rise should be minimal. Increased sway velocity can be caused by weak trunk extension or inability to keep the COG movement to a minimum in the elderly. However in our study, no significant change was noticed in this balance parameter.

In normal aging, step length and speed decreased, turn time increased substantially with aging.

Slow gait speed is associated with falls in aged people. Therapeutic exercises to improve gait speed and step length in osteoporotic elderly can reduce the risk of fall [27,28]. In our study, step speed improved in both control and intervention group which can be contributed to extension exercises administered for patients in both groups.

In the present study, another balance parameter changed in intervention group was right turn time. The ability to make a rapid turn in walking is very crucial and sensitive to dynamic balance problems [29].

There are few studies evaluating the beneficial impacts of spinal orthosis on gait balance [9,29,32].

In 2005, Sinaki [32] conducted a study to determine the outcome of intervention with a spinal weighted kypho-orthosis (WKO) and a spinal proprioceptive extension exercise dynamic (SPEED) program on the risk of fall in osteoporotic patients. After 4 week of intervention, balance, gait, and risk of falls assessed by computerized dynamic posturography improved significantly with SPEED program.

The role of exercise in the treatment of osteoporosis is to improve axial stability through improvement of muscle strength and axial posture [33].

In our study, wearing WKO lead to improvement in turn quick test, mean of excursion and end point excursion. WKO promotes improvement in posture and increased back extensor strength by two mechanisms: first, the device produces a posterior force below the inferior angle of scapula and reduces anterior compressive forces exerted on the kyphotic spine [10]. Second, application of the WKO increases a patient's perception of spinal joint position, which plays an important role in static and dynamic posture. It creates a preprioceptive input and enhances the patient's ability to sense the position of the spine [32]. WKO also promotes muscle re-education and decreases painful contractions of the erector spine muscles in kyphosis [33].

Besides WKO, there are some studies investigating other types of spinal orthoses in osteoporosis. A trial was conducted in 2012 evaluating the influence of ThämertOsteo-med spinal orthosis on gait and physical functioning in osteoporotic women. At a 6-month follow up, the study demonstrated that wearing a spinal orthosis reduced double support time associated with improvement on gait stability [33]. Pfeifer et al. [31] evaluated the efficacy of two spinal orthoses in patients with osteoporotic vertebral fractures. Wearing the orthosis Spinomed in that study was associated with increase in back extensor and abdominal flexor strength, decrease in the angle of kyphosis and body sway, also decrease in average pain [31].

In all above mentioned studies, spinal orthosis had positive effects on postural balance which is in agreement with the results of our studies indicating improvement in LOS, step quick turn and speed in WKO group.

In conclusion, applying WKO together with back extensor strengthening exercises in women with osteoporosis leads to improvement in dynamic balance tests evaluated by NeuroCom which can be translated to decreased risk of fall in real life in this population.

The limitations of our study were the relatively small number of cases included and short term follow ups evaluations. Absence of a control group receiving no intervention was another limitation of this study; however, due to ethical considerations we had to consider the least routine interventions including exercise and medications for all patients.

We encourage more randomized controlled clinical trials with larger sample size evaluating the effect of WKO on risk of fall in long term via applying clinical functional and para clinical tests in the elderly with osteoporosis. Future studies can also consider power calculation to determine adequate sample size that yielded improved power and effect size which was lacking in the present study.

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