J. Phys. Ther. Sci. 29: 1475–1480, 2017

The Journal of Physical Therapy Science

Case Study

Treating 'slouchy' (hyperkyphosis) posture with chiropractic biophysics®: a case report utilizing a multimodal mirror image® rehabilitation program

Miles O. Fortner[1)], Paul A. Oakley[2)*], Deed E. Harrison[3)]

[1)] Private Practice, USA
[2)] Private Practice: Newmarket, ON, L3Y 8Y8, Canada
[3)] CBP Nonprofit Inc., USA

Abstract. [Purpose] To present a case of the non-surgical reduction of 'slouchy' hyperkyphosis posture utilizing the multimodal Chiropractic BioPhysics® rehabilitation program emphasizing the mirror image® concept. [Subject and Methods] A 27-year-old female presented suffering from neck and back pains, headaches and gait dysfunction. The patient was treated 30 times over a period of 6-months. Treatment consisted of anterior thoracic translation, thoracic extension, and head retraction exercises as well as spinal traction and spinal manipulation. [Results] After 6-months of treatment the patient displayed a total correction of the posterior thoracic translation with a significant reduction in thoracic hyperkyphosis. The dramatic correction of her overall posture and spine alignment corresponded to the significant relief of neck and back pains, headaches and improvement of various other health issues as demonstrated by self-report and SF-36. [Conclusion] Poor postures corresponding to poor health can be changed for the better with multimodal rehabilitation programs that are now showing consistent postural improvements corresponding with improvements in various health conditions. We suggest that the postural correction of those with various pain symptoms be considered as a first line non-pharmalogical, non-surgical rehabilitation approach for those presenting with poor posture.
Key words: Hyperkyphosis, Posture, Rehabilitation

(This article was submitted Apr. 10, 2017, and was accepted May 24, 2017)

INTRODUCTION

Posture alignment is of great importance for the maintenance of human health, where a healthy individual has maintained inherent equilibrium of the sagittal spinal curvatures[1–3)]. As global posture and sagittal balance deteriorates, there are normal compensations that take place[4, 5)]. In thoracic hyperkyphosis, for example, it is typical for the thoracic cage to shift or translate backwards such that upright sagittal balance is maintained[6)].

Thoracic hyperkyphosis is associated with many poor health outcomes such as pain[7)], altered gait[8)], compression fractures in the elderly[9, 10)], impaired mobility[9, 10)], as well as reduced quality of life[11, 12)] and life expectancy[13–18)].

Recently, there have been two cases documenting the correction of posterior thoracic translation posture with simultaneous hyperkyphosis reduction[19, 20)]. Jaeger et al.[19)], reported on the relief of back pains in a 24-year-old female who achieved a 23° reduction in the thoracic curve after 48 CBP treatments over 6.5 months. Miller et al.[20)], reported on the dramatic pain relief and health improvements in a 15-year-old who attained a 17° reduction in thoracic hyperkyphosis after 94 treatments over 13-months.

*Corresponding author. Paul A. Oakley (E-mail: docoakley.icc@gmail.com)

Table 1. SF-36. Scores out of 100

	Health Perception	Physcial Functioning	Role-Physical	Role-Emotional	Social Functioning	Mental Health	Bodily Pain	Energy/ Fatigue
Norm	72	84	81	81	83	75	75	61
10/10/2016	77	40	75	100	75	84	48	70
4/5/2017	92	85	100	100	100	88	78	80
Change	15	45	25	0	25	4	30	10

Both of these cases featured Chiropractic BioPhysics® (CBP®) corrective rehabilitation utilizing mirror image® exercise and traction procedures[21–23]. CBP technique was invented by Donald D. Harrison, PhD, DC, MSE, in 1980. He was the first to apply the standard orthogonal (Cartesian) coordinate system as presented by Panjabi et al.[24] to human posture[25]. In doing so, he had discovered that virtually half of all human movement had not yet been studied[25]; further, in applying the concept of rotations about, and translations along the coordinate axes for the head, thorax, and pelvis separately, it became evident to Dr. Harrison to devise treatments in the 'mirror image®' or opposite of these postures in order to correct them and the corresponding spinal coupling patterns[21–23]. In CBP methods, a 'multimodal' approach typically involves the prescription of mirror image exercises and traction, as well as spinal manipulation.

This case presents the successful relief of bodily pains and improvements in overall health in a 27-year-old female after the dramatic improvement in her 'slouchy' posture by the multimodal CBP rehabilitation program featuring the mirror image concept. This case is unique as it appears to be just the third published case documenting the reduction of hyperkyphosis by CBP methods.

SUBJECT AND METHODS

On October 3, 2016 a 27-year-old female, and mother of 3, presented with a chief complaint of constant low back pain (LBP) reported to be an average of 5/10 (0=no pain; 10=worse pain ever) and abnormal gait. Upon consultation, the patient also reported right lower extremity dysfunction, right hip pain, right first toe pain (L5 Dermatome), coldness and cramping in the feet, mid back pain (6/ 10), constant upper back pain (6/10), neck pain (7/10), daily headaches, migraines (1X/month), numbness and tingling in the arms bilaterally with the left worse than the right, cold hands, vertigo that made her unable to walk straight, as well as vision disturbances caused by standing.

The patient's health history indicated they had experienced a previous whiplash episode, a violent physical assault, as well as prior surgery on her right knee to 'trim a meniscus.' Muscle testing revealed weak shoulder abduction (4/5) bilaterally with reported pain, as well as weak hip flexion (4/5) bilaterally with reported pain.

Dermatome testing revealed perceived dullness with pinwheel testing to C2 bilaterally, L4 on left, and S1 on the right. Deep tendon reflexes were within normal limits (WNL). All cervical and lumbar range of motion (ROM) were limited with all movements causing pain.

The following orthopedic tests were positive: Jacksons, maximum compression, foraminal compression, shoulder depression caused radiation of pain bilaterally, straight leg raiser bilaterally, Patrick Faberes test bilaterally, Yoemans test bilaterally, and Hibbs bilaterally.

The patient scored a 44% on the Oswestry low back pain disability questionnaire[26] (OQ) and a 30% on the neck disability index[27] (NDI). The patient scored below normal on 5/8 health domains as demonstrated on the SF-36 questionnaire[28] (SF-36; Table 1)).

In terms of Harrison's postural analysis of rotations and translations of the head, thorax, and pelvis[25], the patient had very pronounced postural hunching with a forward head translation (+TzH), a posteriorly translated thorax (−TzT), a forward translated pelvis (+TzP), a pronounced thoracic hyperkyphosis (+RzT), and a left lateral thoracic translation (+TxT).

Radiographic analysis using reliable and repeatable methods[29–31] utilized in PostureRay (Trinity, FL, USA), indicated the patient had a short left leg (5.4 mm), a lower sacral base on the left (28.2 mm), and a left thoracic translation posture[32] (12.4mm) (Fig. 1). The patient also had a prominent hunched posture with a posteriorly translated torso[6] (−51.4mm; normal=0mm), and a thoracic hyperkyphosis (T2–T12=67°; normal=44.3°[33])) (Fig. 2).

Treatment goals were to improve the patient's posture using the CBP multimodal rehabilitation approach[21–23]. CBP incorporates the mirror image concept, i.e. the reflections of postural body segment translations and rotations[21], ultimately to re-align the spine and posture through the application of therapeutics such as exercises and traction. The recommended treatment frequency and duration was three times a week for a total of 30 treatments.

Initially, a 10 mm lift was applied inside the left shoe to account for the shorter left leg and lower pelvis (Fig. 1). Mirror image corrective exercises consisted of posterior head retraction repetitions with simultaneous posterior pelvic translations having a 50 mm block in the mid back to push against while standing on a PowerPlate® (Northbrook, IL, USA) (Fig. 3). The PowerPlate is a three-dimensional vibration platform that adds intensity to any exercise[34]. Other exercises included

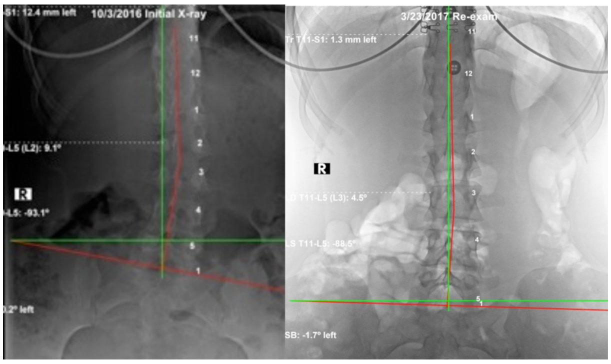

Fig. 1. Antero-posterior lumbar spine radiographs
Left: Initial taken Oct. 3, 2016; Right: Follow-up taken Mar. 23, 2017. Patient has visible short left leg that was reduced with the prescription of a 10 mm heel lift. Notice the simultaneous improvement of the verticality of the spine (1.3 mm to the left of midline vs. 12.4 mm to the right).

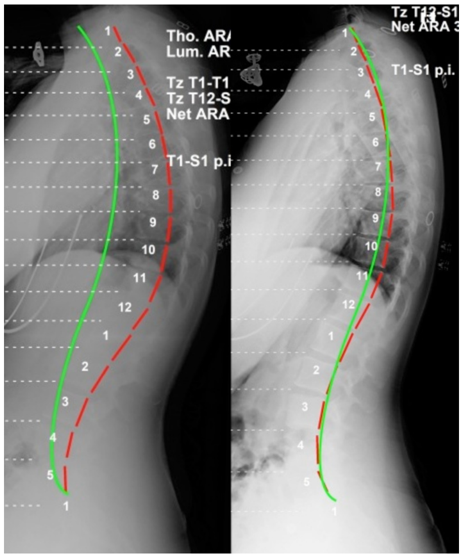

Fig. 2. Lateral full-spine radiographs
Left: Initial taken Oct. 3, 2016; Right: Follow-up taken Mar. 23, 2017. Patient's initial significant posterior thoracic translation posture was improved (Horizontal distance from T12 to vertical line from posteroinferior of S1=−3.7 mm vs. −51.4 mm; normal=0 mm) as was the thoracic hyperkyphosis reduced (T2–T12=55.4° vs. 67°; normal=44.3°[32])).

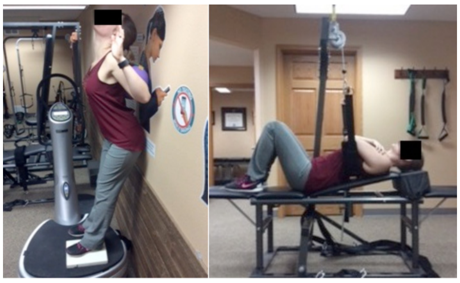

Fig. 3. Left: Mirror image exercises (The patient simultaneously translates the head and pelvis posteriorly while the mid back is isolated in position by use of the block); Right: Mirror image traction (The patients posterior thoracic translation poster is corrected as they lay supine on the bench, while the thoracic kyphosis is being forced into a much more extended position by use of the anterior pulling strap).

one-legged left leg stands on a 50 mm block and pain free ROM exercises, both on the PowerPlate in order to force a mirror image of the AP lumbo-pelvic posture. Each round of exercise was 3 minutes and 15 seconds totaling 9 minutes 45 seconds.

Mirror image drop-table postural adjustments were done while posteriorly translating her head and pelvis while simultaneously anteriorly translating her thorax. Spinal manipulative therapy was also provided sporadically to the thoracic and lumbar spine. Muscle work was performed on the psoas muscles by laying her on her side and compressing the psoas belly between the iliac crest and her rib cage, with pressure on the muscle belly, the patient was asked to flex the hip, then extend the knee, finally extending the hip. This was done four times per side each visit.

Spinal traction was done in a supine UTS unit (Universal Tractioning Systems, LLC., Las Vegas, NV, USA). While laying supine, with hips and knees bent, the thorax was anteriorly translated (+TzT) with a pulling strap located at T9 (Fig. 3). Time was initially started at 5 minutes then worked up to 12–15 minutes of sustained pull. Cryotherapy was applied to the back following traction for 10 minutes to prevent treatment soreness.

The patient was instructed to do the same exercises at home that were done at the clinic. The patient also attempted to mimic the clinic traction by laying supine on a 10 cm yoga block placed at T9 starting at 3 minutes then working up to 15 minutes daily. Also because of the pelvic deformity the patient was instructed to fold a towel approximately 2.5 cm and put under her left ischial tuberosity while she was driving or sitting for long periods of time as this is a permanent structural deformity (Fig. 1). The patient consented to the publication of these results and informed consent was obtained.

RESULTS

Upon re-assessment (Apr. 5, 2017) the patient reported a 100% improvement in Upper back pain and vertigo, an 80% improvement in middle and lower back pain, a 70% improvement in the right leg disuse, a 60% improvement in right hip pain, a 50% improvement in headaches, a 40% improvement in the numbness and tingling in the arms, a 20% improvement in both neck pain and the numbness in the right first toe. On average, the patient now rated the LBP a 2/10, and neck pain a 4/10, and scored an 8% on both the NDI and OQ. There were improvements in 7/8 health indices on the SF-36 (Table 1).

All orthopedic tests were now negative except the S1 dermatome was still hyposensitive, right hip flexion strength was 4/5 without pain, maximum compression on the right was positive, Yoeman's was + bilaterally, the lumbar spine was restricted in lateral flexion, and the cervical spine was restricted in all ROM without pain. The patient was thrilled with her improvements.

Upon radiographic re-assessment, the initial leg length inequality was reduced with the prescription of a 10 mm heel lift to the left shoe (Fig. 1). The initial left lateral shift of the spine was also reduced from 12.4 mm to 1.3 mm (Fig. 1). The large posterior thoracic translation posture was corrected as measured as the horizontal distance from T12 to a vertical line from the postero-inferior of S1 from −51.4 mm to −3.7 mm (normal=0 mm), and the thoracic hyperkyphosis was also reduced as measured from T2–T12 from 67° to 55.4° (normal=44.3°[33]) (Fig. 2).

DISCUSSION

This case illustrates the dramatic correction in overall posture in an initially poorly postured patient suffering from pains, headaches, and many other bodily symptoms that were affecting many aspects of her daily life. The results were attained over a 6-month time period with 30 in-office treatments as well as simultaneous home care.

This case is consistent with two other CBP case reports[19, 20] showing that the reduction in posterior thoracic translation and hyperkyphosis corresponds with the improvement in patient pain levels and other health measures. In all three of these cases (including this one), thoracic mirror image exercises and traction were used to remodel the spinal structures into a more natural, ideal kyphotic alignment[33]. The uniqueness of these cases lies in the application of therapeutic measures in a mirror image approach.

Since posterior thoracic translation causes simultaneous thoracic hyperkyphosis[6], it becomes evident that the 'mirror image' or opposite movement would reverse, or produce thoracic hypokyphosis, which it has been shown to do[6]. Although thoracic (back) extension exercises have been shown to reduce thoracic hyperkyphosis[35–39], the addition of extension traction should theoretically result in better outcomes (i.e. quicker and/or larger magnitude correction). This has yet to be studied.

Thoracic hyperkyphosis is a serious postural deformity as it is associated with serious pathology such as vertebral compression fractures[9, 10] and the ultimate health outcome, mortality[13–18]. Since hyperkyphosis is a progressive type of deformity[40, 41], treatment should be offered at its first diagnosis, even in the absence of symptomatology.

This case and others demonstrates that postural thoracic hyperkyphosis deformity is correctable with the posture- specific CBP multimodal rehabilitation program. This case is also consistent with the recent manual therapy trend that postural deformity is routinely correctable through posture-specific rehabilitation programs such as for the cervical lordosis[42–44], lumbar lordosis[45–47] or with scoliosis[48, 49]. These patient- and posture-specific rehabilitation programs are superior to non-specific, generalized programs of care[42–49].

The limitation to the current case is that it is just a single case. We acknowledge there is only an accumulating evidence base, and therefore a need for a case series and then a clinical trial for the CBP mirror image approach for the reduction of thoracic hyperkyphosis.

REFERENCES

1) Kuntz C 4th, Levin LS, Ondra SL, et al.: Neutral upright sagittal spinal alignment from the occiput to the pelvis in asymptomatic adults: a review and resynthesis of the literature. J Neurosurg Spine, 2007, 6: 104–112. [Medline] [CrossRef]
2) Beck A, Killus J: Normal posture of spine determined by mathematical and statistical methods. Aerosp Med, 1973, 44: 1277–1281. [Medline]
3) Keller TS, Colloca CJ, Harrison DE, et al.: Influence of spine morphology on intervertebral disc loads and stresses in asymptomatic adults: implications for the ideal spine. Spine J, 2005, 5: 297–309. [Medline] [CrossRef]
4) Le Huec JC, Saddiki R, Franke J, et al.: Equilibrium of the human body and the gravity line: the basics. Eur Spine J, 2011, 20: 558–563. [Medline] [CrossRef]
5) Barrey C, Roussouly P, Perrin G, et al.: Sagittal balance disorders in severe degenerative spine. Can we identify the compensatory mechanisms? Eur Spine J, 2011, 20: 626–633. [Medline] [CrossRef]
6) Harrison DE, Cailliet R, Harrison DD, et al.: How do anterior/posterior translations of the thoracic cage affect the sagittal lumbar spine, pelvic tilt, and thoracic kyphosis? Eur Spine J, 2002, 11: 287–293. [Medline] [CrossRef]
7) Petcharaporn M, Pawelek J, Bastrom T, et al.: The relationship between thoracic hyperkyphosis and the Scoliosis Research Society outcomes instrument. Spine, 2007, 32: 2226–2231. [Medline] [CrossRef]
8) Lewis CL, Sahrmann SA: Effect of posture on hip angles and moments during gait. Man Ther, 2015, 20: 176–182. [Medline] [CrossRef]
9) Hall SE, Criddle RA, Comito TL, et al.: A case-control study of quality of life and functional impairment in women with long-standing vertebral osteoporotic

fracture. Osteoporos Int, 1999, 9: 508–515. [Medline] [CrossRef]
10) Lyles KW, Gold DT, Shipp KM, et al.: Association of osteoporotic vertebral compression fractures with impaired functional status. Am J Med, 1993, 94: 595–601. [Medline] [CrossRef]
11) Lonner B, Yoo A, Terran JS, et al.: Effect of spinal deformity on adolescent quality of life: comparison of operative scheuermann kyphosis, adolescent idiopathic scoliosis, and normal controls. Spine, 2013, 38: 1049–1055. [Medline] [CrossRef]
12) Takahashi T, Ishida K, Hirose D, et al.: Trunk deformity is associated with a reduction in outdoor activities of daily living and life satisfaction in community-dwelling older people. Osteoporos Int, 2005, 16: 273–279. [Medline] [CrossRef]
13) Kado DM, Browner WS, Palermo L, et al. Study of Osteoporotic Fractures Research Group: Vertebral fractures and mortality in older women: a prospective study. Arch Intern Med, 1999, 159: 1215–1220. [Medline] [CrossRef]
14) Kado DM, Duong T, Stone KL, et al.: Incident vertebral fractures and mortality in older women: a prospective study. Osteoporos Int, 2003, 14: 589–594. [Medline] [CrossRef]
15) Kado DM, Huang MH, Karlamangla AS, et al.: Hyperkyphotic posture predicts mortality in older community-dwelling men and women: a prospective study. J Am Geriatr Soc, 2004, 52: 1662–1667. [Medline] [CrossRef]
16) Milne JS, Williamson J: A longitudinal study of kyphosis in older people. Age Ageing, 1983, 12: 225–233. [Medline] [CrossRef]
17) Anderson F, Cowan NR: Survival of healthy older people. Br J Prev Soc Med, 1976, 30: 231–232. [Medline]
18) Cutler WB, Friedmann E, Genovese-Stone E: Prevalence of kyphosis in a healthy sample of pre- and postmenopausal women. Am J Phys Med Rehabil, 1993, 72: 219–225. [Medline] [CrossRef]
19) Jaeger JO, Oakley PA, Colloca CJ, et al.: Non-surgical reduction of thoracic hyper-kyphosis in a 24-year old music teacher utilizing chiropractic BioPhysics® technique. Br J Med Med Res, 2016, 11: 1–9. [CrossRef]
20) Miller JM, Oakley PA, Levin SB, et al.: Reversing thoracic hyperkyphosis: a case report featuring mirror image® thoracic extension rehabilitation. J Phys Ther Sci, 2017, (in Press).
21) Harrison DD, Janik TJ, Harrison GR, et al.: Chiropractic biophysics technique: a linear algebra approach to posture in chiropractic. J Manipulative Physiol Ther, 1996, 19: 525–535. [Medline]
22) Oakley PA, Harrison DD, Harrison DE, et al.: Evidence-based protocol for structural rehabilitation of the spine and posture: review of clinical biomechanics of posture (CBP) publications. J Can Chiropr Assoc, 2005, 49: 270–296. [Medline]
23) Harrison DE, Betz JW, Harrison DD, et al.: CBP structural rehabilitation of the lumbar spine. Harrison Chiropractic Biophysics Seminars, 2007.
24) Panjabi MM, White AA 3rd, Brand RA Jr: A note on defining body parts configurations. J Biomech, 1974, 7: 385–387. [Medline] [CrossRef]
25) Harrison DD: Abnormal postural permutations calculated as rotations and translations from an ideal normal upright static posture. In: Sweere JJ, Chiropractic Family Practice. Gaithersburg: Aspen Publishers, 1992, chap 6–1, pp 1–22.
26) Fairbank JC, Couper J, Davies JB, et al.: The Oswestry low back pain disability questionnaire. Physiotherapy, 1980, 66: 271–273. [Medline]
27) Vernon H, Mior S: The neck disability index: a study of reliability and validity. J Manipulative Physiol Ther, 1991, 14: 409–415. [Medline]
28) Ware JE Jr, Sherbourne CD: The MOS 36-item short-form health survey (SF-36). I. Conceptual framework and item selection. Med Care, 1992, 30: 473–483. [Medline] [CrossRef]
29) Harrison DE, Harrison DD, Cailliet R, et al.: Cobb method or Harrison posterior tangent method: which to choose for lateral cervical radiographic analysis. Spine, 2000, 25: 2072–2078. [Medline] [CrossRef]
30) Harrison DE, Holland B, Harrison DD, et al.: Further reliability analysis of the Harrison radiographic line-drawing methods: crossed ICCs for lateral posterior tangents and modified Risser-Ferguson method on AP views. J Manipulative Physiol Ther, 2002, 25: 93–98. [Medline] [CrossRef]
31) Harrison DE, Harrison DD, Colloca CJ, et al.: Repeatability over time of posture, radiograph positioning, and radiograph line drawing: an analysis of six control groups. J Manipulative Physiol Ther, 2003, 26: 87–98. [Medline] [CrossRef]
32) Harrison DE, Cailliet R, Harrison DD, et al.: Lumbar coupling during lateral translations of the thoracic cage relative to a fixed pelvis. Clin Biomech (Bristol, Avon), 1999, 14: 704–709. [Medline] [CrossRef]
33) Harrison DE, Janik TJ, Harrison DD, et al.: Can the thoracic kyphosis be modeled with a simple geometric shape? The results of circular and elliptical modeling in 80 asymptomatic patients. J Spinal Disord Tech, 2002, 15: 213–220. [Medline] [CrossRef]
34) Lee DY: Analysis of muscle activation in each body segment in response to the stimulation intensity of whole-body vibration. J Phys Ther Sci, 2017, 29: 270–273. [Medline] [CrossRef]
35) Pawlowsky SB, Hamel KA, Katzman WB: Stability of kyphosis, strength, and physical performance gains 1 year after a group exercise program in community-dwelling hyperkyphotic older women. Arch Phys Med Rehabil, 2009, 90: 358–361. [Medline] [CrossRef]
36) Itoi E, Sinaki M: Effect of back-strengthening exercise on posture in healthy women 49 to 65 years of age. Mayo Clin Proc, 1994, 69: 1054–1059. [Medline] [CrossRef]
37) Kamali F, Shirazi SA, Ebrahimi S, et al.: Comparison of manual therapy and exercise therapy for postural hyperkyphosis: a randomized clinical trial. Physiother Theory Pract, 2016, 32: 92–97. [Medline] [CrossRef]
38) Katzman WB, Sellmeyer DE, Stewart AL, et al.: Changes in flexed posture, musculoskeletal impairments, and physical performance after group exercise in community-dwelling older women. Arch Phys Med Rehabil, 2007, 88: 192–199. [Medline] [CrossRef]
39) Ball JM, Cagle P, Johnson BE, et al.: Spinal extension exercises prevent natural progression of kyphosis. Osteoporos Int, 2009, 20: 481–489. [Medline] [CrossRef]
40) Fon GT, Pitt MJ, Thies AC Jr: Thoracic kyphosis: range in normal subjects. AJR Am J Roentgenol, 1980, 134: 979–983. [Medline] [CrossRef]
41) Boyle JJ, Milne N, Singer KP: Influence of age on cervicothoracic spinal curvature: an ex vivo radiographic survey. Clin Biomech (Bristol, Avon), 2002, 17: 361–367. [Medline] [CrossRef]
42) Moustafa IM, Diab AA, Harrison DE: The effect of normalizing the sagittal cervical configuration on dizziness, neck pain, and cervicocephalic kinesthetic sensibility: a 1-year randomized controlled study. Eur J Phys Rehabil Med, 2017, 53: 57–71. [Medline]
43) Moustafa IM, Diab AA, Taha S, et al.: Addition of a sagittal cervical posture corrective orthotic device to a multimodal rehabilitation program improves short- and long-term outcomes in patients with discogenic cervical radiculopathy. Arch Phys Med Rehabil, 2016, 97: 2034–2044. [Medline] [CrossRef]

44) Moustafa IM, Diab AA: The effect of adding forward head posture corrective exercises in the management of lumbosacral radiculopathy: a randomized controlled study. J Manipulative Physiol Ther, 2015, 38: 167–178. [Medline] [CrossRef]
45) Diab AA, Moustafa IM: Lumbar lordosis rehabilitation for pain and lumbar segmental motion in chronic mechanical low back pain: a randomized trial. J Manipulative Physiol Ther, 2012, 35: 246–253. [Medline] [CrossRef]
46) Diab AA, Moustafa IM: The efficacy of lumbar extension traction for sagittal alignment in mechanical low back pain: a randomized trial. J Back Musculoskeletal Rehabil, 2013, 26: 213–220. [Medline] [CrossRef]
47) Moustafa IM, Diab AA: Extension traction treatment for patients with discogenic lumbosacral radiculopathy: a randomized controlled trial. Clin Rehabil, 2013, 27: 51–62. [Medline] [CrossRef]
48) Noh DK, You JS, Koh JH, et al.: Effects of novel corrective spinal technique on adolescent idiopathic scoliosis as assessed by radiographic imaging. J Back Musculoskeletal Rehabil, 2014, 27: 331–338. [Medline] [CrossRef]
49) Monticone M, Ambrosini E, Cazzaniga D, et al.: Active self-correction and task-oriented exercises reduce spinal deformity and improve quality of life in subjects with mild adolescent idiopathic scoliosis. Results of a randomised controlled trial. Eur Spine J, 2014, 23: 1204–1214. [Medline] [CrossRef]