



Case Study

## The CBP<sup>®</sup> mirror image<sup>®</sup> approach to reducing thoracic hyperkyphosis: a retrospective case series of 10 patients

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**Abstract.** [Purpose] To present a case series demonstrating the reduction of thoracic hyperkyphosis by the Chiropractic BioPhysics<sup>®</sup> multimodal rehabilitation program. [Participants and Methods] Ten randomly selected files and corresponding radiographs were chosen from recent clinic archives of patients who were treated for thoracic hyperkyphosis. All patients were treated by CBP mirror image<sup>®</sup> thoracic extension traction and exercises, as well as spinal manipulative therapy. [Results] Results demonstrated an average reduction in hyperkyphosis of 11.3° over an average of 25 treatments, over an average of 9 weeks. Patients also experienced a reduction in pain levels and disability ratings. [Conclusion] Postural hyperkyphosis is a serious progressive deformity that is related to a plethora of symptoms, syndromes, and early death. Thoracic hyperkyphosis may be reduced/corrected by posture-specific, thoracic extension protocols including mirror image extension traction and exercises, as well as spinal manipulation as part of the CBP multi-modal rehabilitation program.

**Key words:** Thoracic hyperkyphosis, Spinal rehabilitation, Adult spinal deformity

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### INTRODUCTION

Thoracic hyperkyphosis is a spine deformity that is associated with a variety of health-related quality of life measures<sup>1-4)</sup>, spinal pain<sup>5, 6)</sup>, compression of internal organs that lead to reduced lung capacity<sup>7, 8)</sup>, reduced rib mobility<sup>8)</sup>, reduced spine mobility<sup>9)</sup>, uterine prolapse<sup>10, 11)</sup>, gastric hernia<sup>12)</sup>, as well as spinal compression fractures<sup>13, 14)</sup>. More alarming, many clinical trials have verified a link between increased thoracic kyphotic deformity and reduced life expectancy<sup>15-20)</sup>.

There is a popular assumption that thoracic hyperkyphosis is associated with osteoporotic compression fractures. This is because the severity of thoracic kyphosis deformity has been shown to progress with a decrease in bone mineral density with aging<sup>21)</sup>, and in advanced osteoporosis, compression fractures lead to a loss of vertebral body height and the formation of a progressive kyphotic deformity (aka 'Dowager's Hump')<sup>22)</sup>. This leads to the often associated mid back pain and inflexibility<sup>23, 24)</sup>. The popular assumption that hyperkyphosis most often results from compression fractures in patients with advanced osteoporosis, however, is a myth.

Many studies, in fact, have documented that large proportions of thoracic hyperkyphosis patient populations, up to 70%, may be void of vertebral fractures<sup>6, 7, 25, 26)</sup>. Since this deformity is progressive, even in the absence of vertebral compression fractures<sup>27-30)</sup>, and due to the serious negative future prognosis on health, the importance of correcting thoracic hyperkyphosis earlier in life is more ideal rather than later in life when the deformity becomes well advanced and more difficult to treat. It would seem prudent to recommend treatment be pursued at the earliest diagnosis even in the absence of symptoms.

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The SOSORT (Society on Scoliosis Orthopaedic and Rehabilitation Treatment) consensus on the treatment of idiopathic and Scheuermann's kyphosis also supports treatment for primary reasons other than pain reduction<sup>31</sup>).

The same SOSORT consensus paper (2010)<sup>31</sup>) stated that there is "no sound scientific data available" on effective non-surgical, conservative treatments for thoracic hyperkyphosis. Although this consensus is now dated, there are emerging conservative treatment options that show initial evidence of hyperkyphosis reduction; these include:<sup>32, 33</sup>) exercise, manual therapy, spinal orthosis, 'practiced normal posture,' taping, and more recently, thoracic extension traction<sup>34-36</sup>).

To our knowledge, there have been only three single case reports and one case series (n=3) on the reduction of thoracic hyperkyphosis by extension traction reported in the literature<sup>34-37</sup>). In these cases, thoracic extension traction was combined with extension exercises and spinal manipulative therapy (SMT). Jaeger et al.<sup>34</sup>) reported a 23° reduction of thoracic curve in a 24 year old with 48 treatments with additional home care over a 6.5-month period, Miller et al.<sup>35</sup>) reported a 17° reduction in a 17 year old female with 94 treatments over a 13-month period, Fortner et al.<sup>36</sup>) reported a 12° reduction in a 27 year old female with 30 treatments as well as home care, over a 6-month period, and in the series by Fedorchuk et al.<sup>37</sup>), an average reduction of 11° was achieved in three patients after 10-weeks of care.

This case series reports on the results of ten patients who were treated for thoracic hyperkyphosis by mirror image thoracic extension exercise and traction as well as SMT as a part of Chiropractic BioPhysics® (CBP®) methods.

## PARTICIPANTS AND METHODS

A random selection of patient clinical files and their corresponding radiographs were retrieved from one of two spine clinics located in Las Vegas, NV. The criteria included adult patients ( $\geq 18$  years) treated for thoracic hyperkyphosis. Thoracic hyperkyphosis was measured from a lateral thoracic radiograph using the Harrison posterior tangent (HPT) method<sup>38</sup>) and was determined to be an absolute rotation angle (ARA) from T1–T12 of 50° or greater, where 43.7° represents an average normal<sup>39</sup>).

The exclusion criteria included the presence of scoliosis, receiving concurrent treatment elsewhere, the presence of at least one or more vertebral compression fracture(s), patients who discontinued care and/or who did not have follow-up radiographic data. The first ten cases located were included; although files were available from March, 2005 (opening of first of two clinics), there was an emphasis to select more recent files.

Selected patient files were reviewed for demographic information including age at presentation, height, weight and gender (Table 1). Pre- and post-treatment pain and quality of life data including numeric rating score (NRS) for pain (0=no pain; 10=worst pain ever), and a general disability index questionnaire (GDI) were recorded. Treatment information was attained including the number of treatments, treatment duration in weeks, and the particulars of specific treatment modalities including exercises, traction, and manual therapy.

Radiographic information was reviewed for pre and post T1–T12 ARA values. All radiographs were measured using the PostureRay system (Trinity, FL, USA). This system uses the HPT method for measuring lateral curves of the spine<sup>38, 40, 41</sup>). The HPT method has a standard error of measurement of  $< 2^\circ$ , and an intra- and inter-class correlation coefficient of  $\geq 0.96$  for the measurement of T1–T12<sup>38</sup>).

Patients were treated by CBP® protocol<sup>42-45</sup>); this technique involves application of mathematical concepts applied to the correction of posture, namely by the use of mirror image® or oppositely prescribed exercises, adjustments, and traction procedures as compared to the patient presentation. Patients presenting with thoracic hyperkyphosis, for example, are prescribed thoracic extension protocols to correct this deformity. This technique was originated by Don Harrison, a former chiropractor and mathematician, and has evolved to being used by other manual therapists including physiotherapists<sup>46-51</sup>).

Thoracic extension traction involved the use of the Universal Traction System® (UTS®, Las Vegas, NV, USA). The UTS enables multiple vectors of pull and treatment of each spinal region; specifically, one, two, or three-point bending traction in a seated, standing or supine position can be performed. Specifically, the patient was in a seated position with the top of the thighs strapped. A strap placed mid thorax, at the apex of the hyperkyphosis, pulling anteriorly, and a strap was placed across the superior aspect of the shoulders keeping the patient secure (Fig. 1). An alternative set-up was used if the patient had a posterior thoracic translation or negative sagittal balance (Fig. 2). In this version, a block was placed behind the torso to have it positioned in its mirror image position. Traction was performed for 15 minutes.

Thoracic extension exercises were performed with the patient standing against a wall with a block positioned between the pelvis and wall where the patient would translate their thorax forwards keeping the body upright, forcing an extension of the thoracic spine (Fig. 3). A second exercise was performed with the patient laying prone, extending the upper torso and head as well as the legs and feet (Fig. 4). These exercises were graduated up to 50 repetitions holding for 3 seconds. SMT was performed to spinal areas perceived to be fixated on a treatment-to-treatment basis.

This study received IRB approved waiver of informed consent through IntegReview IRB (www.integreview.com) on August 30, 2017 (protocol No. CBP2017-003).

**Table 1.** Demographic, radiographic, pain and disability scores pre- and post-treatment

Pt No.	Age yrs	Gender	Ht cm	Wt kg	bmi	No. txt	No. of weeks	Initial ARA (°)	F/up ARA (°)	ARA change (°)	Initial pain /10	F/up Pain /10	Initial GDI /60	F/up GDI /60
1	31	M	190.5	104.3	28.7	12	4	61.6	47.1	14.5	0	0	0	0
2	68	M	180.3	88.5	27.2	36	12	60.8	45.9	14.9	1	1	12	12
3	34	F	165.1	86.2	31.6	12	4	68.6	63.3	5.3	7	0	28	0
4	20	F	152.4	56.7	24.4	24	8	51.5	42.1	9.4	6	1	31	7
5	33	M	177.8	86.2	27.3	36	12	50.4	46.4	4.0	1	1	11	3
6	67	M	163.8	72.1	26.9	36	12	76.9	47.3	29.6	2	1	11	6
7	63	M	175.3	77.1	25.1	12	4	52.5	45.0	7.5	6	2	31	2
8	44	F	157.8	57.6	23.1	24	8	54.5	45.9	8.6	3	4	19	1
9	22	M	182.8	98.9	29.6	36	12	65.0	58.8	6.2	7	2	11	0
10	24	F	177.0	63.5	20.3	24	14	64.9	52.0	12.9	6	0	9	0
n=10	40.6	4F; 6M	171.8	79.1	26.4	25.2	9.0	60.7	49.4	11.3	3.9	1.2	16.3	3.1

Pt: patient; Ht: height; Wt: weight; BMI: body mass index; ARA: absolute rotation angle; GDI: general disability index; F/up: follow-up assessment.



**Fig. 1.** Mirror image thoracic extension traction. Patient is in a seated position with the top of the thighs strapped. A strap is placed mid thorax (at the apex of the hyperkyphosis) and pulls anteriorly. A final strap is placed across the superior aspect of the shoulders keeping the patient secure.



**Fig. 2.** Mirror image thoracic extension traction. An alternative set-up is used if the patient had a posterior thoracic translation posture or negative sagittal balance. In this version, a block is placed behind the torso to have it positioned in its mirror image position.

## RESULTS

Table 1 summarizes the demographic data of the sample. There were 4 females and 6 males, having an average age of 40.6 years (range 20–68 years), average height of 172.3 cm, average weight of 79.1 kg, and an average BMI of 26.4. The average hyperkyphosis ARA angle from T1–T12 was  $60.7^\circ (\pm 8.6^\circ)$ , the average NRS pain level was 3.9/10, and the average GDI score was 27% (16.3/60).

The average number of treatments was 25 (range 12–36), and the average duration of treatment was 9 weeks (range 4–14 weeks) (Table 1). Patient treatment number and frequency varied depending on patient health insurance and commitment to care. After treatment, the average reduction in thoracic kyphosis was  $11.3^\circ$  ( $49.4^\circ$  vs.  $60.7^\circ$ ), with a 3-point reduction in NRS (1.2/10 vs. 3.9/10) and a 22% reduction in GDI score (5% vs. 27%).



**Fig 3.** Mirror image thoracic extension exercise. Patient stands facing a wall trapping a block between the pelvis and the wall. The patient anteriorly translates their torso keeping the body vertical forcing an extension throughout the thoracic spine.



**Fig. 4.** Mirror image thoracic extension exercise. Patient lays prone and extends their upper torso and head as well as their legs and feet forcing a thoracic extension.

## DISCUSSION

This randomly selected series of cases illustrates that the CBP mirror image treatment protocol can reliably and consistently reduce thoracic hyperkyphosis in adults with spinal pains and reduced quality of life presenting with an initial T1–T12 ARA  $>50^\circ$ . This series adds to previous reports by Jaeger et al.<sup>34</sup>, Miller et al.<sup>35</sup>, Fortner et al.<sup>36</sup> and Fedorchuk et al.<sup>37</sup> that CBP mirror image methods can successfully reduce pathologic thoracic kyphosis and reduce/alleviate the associated spinal pains and negative health impact.

The results of this series are strengthened by the fact that standing radiographic methods were used to measure the kyphosis angle, the gold-standard orthopedic technique<sup>33</sup>. Other studies have used non-radiographic methods such as the Debrunner kyphometer, a posture board, distance between wall to the occiput or tragus, and number of 1.5 cm blocks necessary to support the head<sup>52</sup>; however, only the kyphometer has been directly compared to radiography for an agreement assessment where it was determined for Cobb angle kyphosis measurements  $<50^\circ$  it had acceptable agreement (ICC=0.68), but for kyphosis angles  $>50^\circ$ , the very population to be concerned about, it had poor agreement (ICC=0.44)<sup>52</sup>.

The only pre-post intervention trial demonstrating pre-post radiography reduction in thoracic hyperkyphosis participants was by Itoi and Sinaki<sup>53</sup>. They assessed the efficacy of a two-year exercise program on estrogen-deficient women aged 49–65. They found no difference after two years between the treatment group and control group, however, when re-analyzing their data they found that for those participants who increased their back extensor strength (n=13; 9 from exercise group, 4 from control group), their kyphosis reduced by  $2.8^\circ$ . They also measured the kyphosis using the Cobb method from the inferior border of T4 to the end of the kyphosis, which obviously would slightly under-estimated kyphosis values.

The patients treated in this study performed back extensor exercises which have been proven to decrease thoracic hyperkyphosis<sup>54–56</sup> as well as back extension traction. The traction aspect of the CBP treatment protocol probably accounts for a substantial amount of the kyphosis reduction as it is targeting the visco-elastic properties<sup>57</sup> of the intervertebral discs and ligamentous tissues to cause creep (deformation over time<sup>58</sup>) and plastic deformation (structure permanently deforms<sup>58</sup>) to reduce the thoracic curve.

CBP traction is performed between 10–20 minutes<sup>43–45</sup>, or at least greater than 5 minutes<sup>57</sup>) to overcome the elastic recoil of the spinal tissues such as which happens with exercises and SMT. Just as unique CBP mirror image traction methods have proven effective to increase the cervical lordosis<sup>46–48,59–61</sup>, lumbar lordosis<sup>49–51,62</sup>, and lateral head<sup>63</sup> and thorax<sup>64</sup> postures, the relatively large magnitude in reduction of thoracic kyphosis in this case series ( $>11^\circ$ ) is undoubtedly due to the combined effects of extension traction and extension exercises and SMT as part of a multimodal exercise program. Evidence suggests multimodal programs are more effective than monotherapies for low back pain<sup>65</sup>; this undoubtedly applies to exercise



programs for the treatment of thoracic hyperkyphosis.

We used the HPT method for measuring the thoracic kyphosis; this entails a line drawn on the posterior vertebral body margins of T1 and T12 thoracic vertebra<sup>38</sup>. The HPT method is thought to be a better measure for the lateral thoracic view as it is the slope along the curve in engineering analyses, as opposed to the Cobb method which is an attempt to measure angles at different cross-sections of thoracic kyphosis, and is subject to overestimation when there are anterior vertebral body height changes due to genetics or pathology<sup>38</sup>.

We chose the T1–T12 ARA of greater than 50° as inclusion for diagnosis of thoracic kyphosis. While this number is less than one standard deviation (SD) greater than the average normal thoracic kyphosis determined by Harrison et al. of 43.7° (± 11.4°)<sup>39</sup>, we argue this is clinically significant.

It seems that clinically relevant normal values for spinal parameters may have tighter ranges around an average versus simply adding and subtracting one or more standard deviations (SD). Harrison et al. for example, were able to statistically differentiate asymptomatic individuals from both chronic and acute neck pain patients based on the lateral cervical curvature. Normals, acute pain, and chronic pain participants had C2–C7 ARA means of 34.5° (± 9.8°), 28.6° (± 10.6°), and 22.0° (± 14.6°)<sup>51</sup>, respectively. In this study it is noted that the pain groups' cut-offs were smaller than one SD added or subtracted to the adjacent group's mean lordosis angle value. In fact, simply adding or subtracting a single SD to the average of either of the groups (normal, acute pain or chronic pain groups) would have overlapped the participants.

The global thoracic kyphosis was measured from T1–T12 in this series. There may be limitations to include the entire kyphosis as the cephalad and caudad portions of the curve may be affected by adjacent spine region deformities, such forward head posture and cervical hyperlordosis (increase upper kyphosis) or cervical kyphosis (decrease upper kyphosis) and/or thoracic cage sagittal imbalance of forward translations (decrease lower kyphosis) or backward translations (increase lower kyphosis). A more robust measure of kyphosis may be from T3–T10, which would include the largest segmental portions contributing to the overall curve, and would eliminate the upper (T1–T2) and lower (T11–T12) portions that may be affected by adjacent region postural alterations. Our sample was a heterogeneous group of ten randomly selected patients whose ages ranged from 20–68; differences in treatment effect for younger versus older patients who have had the condition developing longer need to be clarified in future study.

Since thoracic hyperkyphosis is a progressive deformity with serious potential health consequences, and CBP protocol is proven to offer a reliable method to reduce the deformity non-surgically, we propose these methods to be the treatment of choice offered by therapists with patients presenting with this deformity. We also urge continued research in evaluating the CBP protocol in the reduction of thoracic hyperkyphosis including larger case series and clinical trials.

### *Conflict of interest*

PAO is paid by CBP NonProfit for writing the manuscript; JOJ and DEH teach rehabilitation methods and sell products to physicians for patient care as used in this manuscript.

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