Case Study

Alleviation of chronic spine pain and headaches by reducing forward head posture and thoracic hyperkyphosis: a CBP® case report

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Abstract. [Purpose] This case presents the reduction of both forward head posture and thoracic hyperkyphosis in a young male with chronic back pain and headaches by a comprehensive posture rehabilitation program as a part of Chiropractic BioPhysics® methods. [Participant and Methods] A 32 year old male presented with constant pain and headaches for seven years since he was involved in a work related injury. He had seen five different MDs, undergone multiple imaging tests, and received multiple prescriptions, thirteen steroid injections and was recommended for a spine surgery that he had denied. He was on long-term disability. Upon comprehensive posture and spine assessment, the patient had exaggerated forward head translation and thoracic hyperkyphosis. The patient was treated 36 times over 13-weeks with cervical and thoracic extension exercises, traction, and manipulation. [Results] After treatment the patient reported dramatic improvement in symptoms as indicated on valid disability questionnaires and substantial improvements in posture. [Conclusion] Posture-related pain and disability is not often addressed in allopathic medicine but substantial posture improvements are achievable in short time periods as this case illustrates. Poor postures in young patients should be corrected to avoid long-term consequences. Radiography as used in spinal rehabilitation is safe and reliable.

Key words: Thoracic kyphosis, Anterior head translation, Posture rehabilitation

INTRODUCTION

Deterioration of upright posture has been observed to occur with aging1–5). A common postural pattern is the forward shift of the head (anterior head translation: AHT) and the progressive slouching of the upper and middle back termed thoracic hyperkyphosis (THK)6).

THK is a serious diagnosis as it is associated with many deleterious health outcomes such as early death6–10), pain11), altered gait12), compression fractures6, 13), and reduced quality of life14, 15). When this postural pattern is seen in the younger patient, it is particularly concerning, as the normal (untreated) prognosis is a worsening of spinal deformity and onset of associated disease. Debra Kado, MD, has termed THK as a syndrome in its own right16).

The early diagnosis and treatment of THK is essential in the prevention of the otherwise associated typical poor health outcomes. Several clinical trials and case reports have documented the successful non-surgical reduction of THK in patients17–26). These methods primarily involve back extension exercise regimens, and more recently thoracic extension traction methods23–26).

This case presents the reduction of both AHT and THK in a young male with chronic back pain and headaches by a combination of cervico-thoracic extension exercises and traction methods as a part of Chiropractic BioPhysics® (CBP®) methods.
A 32 year old male presented reporting to be in constant pain for seven years since he was involved in a work related injury where his truck rolled over on a county road. He had undergone multiple CT scans, X-rays, and MRI imaging, and had seen five different MDs regarding his chief complaint of severe mid back pain. He received multiple pain medicine prescriptions, thirteen steroid injections and was recommended for a three level fusion in the thoracic spine that he had denied. He ended up on long-term disability when he presented to our spine clinic.

The patient’s primary complaint was severe middle back pain. He also suffered from neck pain, low back pain, daily headaches, and dizziness. The patient reported the mid back pain to average a 5/10 (0=no pain; 10=worst pain ever) and could be an 8/10 at worst, scored a 38% on the neck disability index (NDI)\(^{27}\), and a 28% on the headache disability index (HDI)\(^{28}\). The patient also scored poorly on many categories on the RAND quality of life questionnaire (SF-36)\(^{29}\) (Table 1).

Range of motion assessment showed reduced cervical bilateral bending as well as cervical extension was within normal limits (WNL) but produced pain. The patient demonstrated weak cervical flexion (4/5) as well as had positive cervical compression, maximum bilateral foraminal compression, bilateral Hibbs, and bilateral Yoemans tests. Handgrip strength was limits (WNL) but produced pain. The patient demonstrated weak cervical flexion (4/5) as well as had positive cervical compression, maximum bilateral foraminal compression, bilateral Hibbs, and bilateral Yoemans tests. Handgrip strength was

The patient was given spinal manipulative therapy to mobilize the spinal joints as well as mirror image drop table postural maneuvers to stress posterior translation of the head as well as extension of the thoracic spine; that is the head piece was positioned on a block against the wall and by facing the wall with a block placed at the pelvis against the wall (Fig. 4). Foam rolling to the mid thoracic spine area would proceed the exercises. Each exercise was done for approximately three minutes.

The patient did spinal traction in a supine UTS (Universal Tractioning Systems, LLC., Las Vegas, NV, USA) strapping the femurs down and pulling up (anteriorly) at T9, allowing the head to extend and retract (Fig. 5). The patient was also given a daily home care regimen of first foam rolling, 100 repetitions of the above mentioned exercises, and traction using a thoracic Denneroll\(^{TM}\) (Denneroll Spinal Orthotics, Wheeler Heights, NSW, Australia) placed at T9 for up to 15 minutes. The patient gave verbal and written consent for the publication of these results.

### RESULTS

Upon re-assessment (12/6/17) the patient reported to be 90% improved for the primary complaint of mid back pain as well as headaches and dizziness. He reported his back pain to average 1/10 and the scores on the NDI and HDI were 4% and 0%, respectively. SF-36 scores were significantly improved; in fact initially the patient was below normal on all health indices and

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### Table 1. SF-36. Scores out of 100

| Date      | Health perception | Physical functioning | Role-Physical | Role-Emotional | Social functioning | Mental health | Bodily pain | Energy/fatigue |
|-----------|------------------|----------------------|---------------|----------------|-------------------|---------------|-------------|----------------|
| Normal    | 72               | 84                   | 81            | 81             | 83                | 75            | 75          | 61             |
| 8-30-17   | 50               | 50                   | 0             | 33             | 50                | 48            | 45          | 20             |
| 11-08-17  | 77               | 90                   | 75            | 100            | 100               | 60            | 55          | 40             |
| 12-06-17  | 87               | 90                   | 100           | 100            | 100               | 76            | 78          | 70             |

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### PARTICIPANT AND METHODS

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after treatment was above normal for all (Table 1).

Visually, the patient’s posture was much improved and all orthopaedic tests were WNL except he demonstrated a positive Hibbs on the left and had reduced right lateral flexion of the cervical spine. His handgrip strength improved on the left to 34 kgs (29.5 kgs on right).

Radiographic analysis showed an improved AHT (23.1 mm vs. 38.2 mm), APL (−18.5° vs. 0.3°), increased cervical lordosis (−22.4° vs. −12.4°), reduced thoracic kyphosis (46.4° vs. 55.2°), and improved thoracic sagittal balance (T1–T12: 9.3 mm vs. 43.3 mm).

Fig. 1. Lateral cervical radiographs. Left: Initial (8/28/17); Right: Follow-up (12/6/17). Green line indicates normal ideal cervical lordosis; red line highlights patient posterior vertebral body margins (CBP Seminars, Inc.).

Fig. 2. Lateral thoracic radiographs. Left: Initial (8/28/17); Right: Follow-up (12/6/17). Green line indicates normal thoracic kyphosis; red line highlights patient posterior vertebral body margins (CBP Seminars, Inc.).

Fig. 3. Cervical mirror image hyperextension exercise.

Fig. 4. Thoracic extension exercises. Left: Patient is anteriorly translating their thorax towards the wall and extending the head; Right: Patient is simultaneously retracting their head and pelvis towards the wall.
DISCUSSION

This case demonstrates the resolution of chronic back pain and daily headaches with the improvement of posture and reduction of AHT and THK. The treatment was performed over 13-weeks and valid disability and quality of life questionnaires documented the dramatic health improvements.

As mentioned, THK should be considered its own ‘syndrome’6). Kado refers to it being a ‘geriatric syndrome’ because of its association with a plethora of future dire health consequences6–16). When this posture is diagnosed in a younger individual, as in this case, it may be more serious. This is because posture tends to deteriorate over time1–5), so the worse ones posture is at a younger age, the greater potential for worsening. Thus, we concur with Jaeger et al. who suggest that the correction of this deformity should be achieved earlier rather than later23).

Since spinal pain and headache is associated with deviations of spinal posture45–51), the preservation of upright posture and spine alignment should be the goal for patients having back pains and/or headache. The CBP methods utilized in this case are well studied52–64), and extension type traction and exercise procedures should be incorporated into rehabilitation programs for those suffering from THK and AHT.

It should be mentioned that radiographs were used to document the severity of the posture and spine alignment30–33). The Harrison posterior tangent method (lines along the posterior body margins) is repeatable and reliable and has an error margin that is less than 2 mm and 2 degrees rendering the method an exceptional technique to quantify spine alignment. X-rays are the preferred method of assessing body posture as the internal spine alignment is not visualized by other means, for example, by photography. Further, because THK is commonly associated with vertebral compression fracture6, 13), definitive knowledge of the presence of fracture is important for ‘correction potential’ as fractures of course, would limit the amount of posture/spine improvement.

There is a current push in medicine for the decrease of imaging that involves radiation for fear of future cancers65–67). This effort is futile however, as all cancer risks are estimated based on a faulty linear model (linear no-threshold model: LNT), and it does not consider the healing faculties of the body65–70). It has been a hotly debated topic, but recently there have been calls for the elimination of the LNT model as used in radiation safety as it is argued that there is actually no data that exists to support that low-dose radiation as used in radiography will ever contribute to future cancer development65–70). Thus use of radiography for spine and posture assessment and quantification is a reliable and safe practice. Practitioners and patients should not be dissuaded from radiographic imaging based on unfounded fears.

A limitation to this case is the lack of a long-term follow-up. Further, multiple treatments were given during treatment, thus it is unknown which aspect of the treatment was most responsible for the posture improvements; although based on previous studies it seems that extension traction of the spine results in structural posture improvements57–64), exercises may also contribute to improving THK17–22). Further research into non-surgical rehabilitation approaches to reversing AHT and THK need to clarify these issues.

Conflict of interest

PAO is paid by CBP NonProfit, for writing the manuscript; DEH teaches chiropractic rehabilitation methods and sells products for patient care as used in this manuscript.
REFERENCES

1. Fon GT, Pitt MJ, Thies AC Jr: Thoracic kyphosis: range in normal subjects. AJR Am J Roentgenol, 1980, 134: 979–983. [Medline] [CrossRef]

2. Korovessis PG, Stamatakis MV, Baikousis AG: Reciprocal angulation of vertebral bodies in the sagittal plane in an asymptomatic Greek population. Spine, 1998, 23: 700–704, discussion 704–705. [Medline] [CrossRef]

3. Park MS, Moon SH, Lee HM, et al.: The effect of age on cervical sagittal alignment: normative data on 100 asymptomatic subjects. Spine, 2013, 38: E458–E463. [Medline] [CrossRef]

4. Boyle JJ, Milne N, Singer KP: Influence of age on cervicothoracic sagittal curvature: an ex vivo radiographic survey. Clin Biomech (Bristol, Avon), 2002, 17: 361–367. [Medline] [CrossRef]

5. Milne JS, Lauder IJ: Age effects in kyphosis and lordosis in adults. Ann Hum Biol, 1974, 1: 327–337. [Medline] [CrossRef]

6. 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]

7. 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]

8. Milne JS, Williamson J: A longitudinal study of kyphosis in older people. Age Ageing, 1983, 12: 225–233. [Medline] [CrossRef]

9. Anderson F, Cowan NR: Survival of healthy older people. Br J Prev Soc Med, 1976, 30: 231–232. [Medline]

10. Cutler WB, Friedman 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]

11. Petcharaporn M, Pawelek J, Bastron T, et al.: The relationship between thoracic hyperkyphosis and the Scoliosis Research Society outcomes instrument. Spine, 2007, 32: 2226–2231. [Medline] [CrossRef]

12. Lewis CL, Sahrmann SA: Effect of posture on hip angles and moments during gait. Man Ther, 2015, 20: 176–182. [Medline] [CrossRef]

13. 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]

14. Lonner B, Yao 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]

15. Takashashi 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]

16. Kado DM, Lui LY, Ensrud KE, et al. Study of Osteoporotic Fractures: Hyperkyphosis predicts mortality independent of vertebral osteoporosis in older women. Ann Intern Med, 2009, 150: 681–687. [Medline] [CrossRef]

17. Pawlowsky SB, Hanem 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]

18. 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]

19. Kamali F, Shirazi SA, Ebrahimí 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]

20. 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]

21. Ball JM, Cagle P, Johnson BE, et al.: Spinal extension exercises prevent natural progression of kyphosis. Osteoporos Int, 2009, 20: 481–489. [Medline] [CrossRef]

22. Katzman WB, Vittinghoff E, Lin F, et al.: Targeted spine strengthening exercise and posture training program to reduce hyperkyphosis in older adults: results from the study of hyperkyphosis, exercise, and function (SHEAF) randomized controlled trial. Osteoporos Int, 2017, 28: 2831–2841. [Medline] [CrossRef]

23. 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 Res, 2016, 11: 1–9. [CrossRef]

24. Miller JE, Oakley PA, Levin SB, et al.: Reversing thoracic hyperkyphosis: a case report featuring mirror image® thoracic extension rehabilitation. J Phys Ther Sci, 2017, 29: 1264–1267. [Medline] [CrossRef]

25. Fortner MO, Oakley PA, Harrison DE: Treating ‘slouchy’ (hyperkyphosis) posture with chiropractic biophysics®: a case report utilizing a multimodal mirror image® rehabilitation program. J Phys Ther Sci, 2017, 29: 1475–1488. [Medline] [CrossRef]

26. Fedoruchk C, Snow E: Increased lung function & quality of life in asymptomatic subjects following reduction in thoracic hyperkyphosis & vertebral subluxation utilizing chiropractic biophysics: a case series. Ann Vert Sublux Res, Oct 12, 2017: 189–200.

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. Jacobson GP, Ramadan NM, Aggarwal SK, et al.: The Henry Ford Hospital Headache Disability Inventory (HDI). Neurology, 1994, 44: 837–842. [Medline] [CrossRef]

29. Waiz 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]

30. Harrison DE, Harrison DD, Caillet 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]

31. Harrison DE, Caillet R, Harrison DD, et al.: Reliability of centroid, Cobb, and Harrison posterior tangent methods: which to choose for analysis of thoracic kyphosis. Spine, 2001, 26: E227–E234. [Medline] [CrossRef]

32. Harrison DE, Harrison DD, Cailliet R, et al.: Cobb method or Harrison posterior tangent method: which to choose for lateral cervical radiographic analysis. Spine, 2001, 26: E235–E242. [Medline] [CrossRef]

33. 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]
34) 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]
35) Harrison DD, Harrison DE, Janik TJ, et al.: Modeling of the sagittal cervical spine as a method to discriminate hypolordosis: results of elliptical and circular modeling in 72 asymptomatic subjects, 52 acute neck pain subjects, and 70 chronic neck pain subjects. Spine, 2004, 29: 2485–2492. [Medline] [CrossRef]
36) McAviney J, Schulz D, Bock R, et al.: Determining the relationship between cervical lordosis and neck complaints. J Manipulative Physiol Ther, 2005, 28: 187–193. [Medline] [CrossRef]
37) Harrison DD, Janik TJ, Troyanovich SJ, et al.: Comparisons of lordotic cervical spine curvatures to a theoretical ideal model of the static sagittal cervical spine. Spine, 1996, 21: 667–675. [Medline] [CrossRef]
38) 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]
39) Harrison DE, 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]
40) 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]
41) Harrison DE, Harrison DD, Haas JW: Structural rehabilitation of the cervical spine. Evanston, WY: Harrison CBP, 2002.
42) Oliver MJ, Twomey LT: Extension creep in the lumbar spine. Clin Biomech (Bristol, Avon), 1995, 10: 363–368. [Medline] [CrossRef]
43) Harrison DD, Janik TJ, Harrison GR, et al.: Increasing the cervical lordosis with chiropractic biophysics seated combined extension-compression and transverse load cervical traction with cervical manipulation: nonrandomized clinical controlled trial. J Manipulative Physiol Ther, 2003, 26: 139–151. [Medline] [CrossRef]
44) 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: 34–38. [Medline] [CrossRef]
45) Fernández-de-Las-Peñas C, Alonso-Blanco C, Cuadrado ML, et al.: Myofascial trigger points and their relationship to headache clinical parameters in chronic tension-type headache. Headache, 2006, 46: 1264–1272. [Medline] [CrossRef]
46) Harrison DE, Harrison DD, Betz JJ, et al.: Comparison of lordotic cervical spine curvatures to a theoretical ideal model of the static sagittal cervical spine. Spine, 1996, 21: 529–536. [Medline] [CrossRef]
47) Harrison DE, Harrison DD, Haas JW: The efficacy of cervical lordosis rehabilitation for nerve root function, pain, and segmental motion in cervical spondylotic radiculopathy subjects? J Back Musculoskeletal Rehabil, 2017, 30: 937–941. [Medline] [CrossRef]
65) Siegel JA, Sacks B: Eliminating use of the linear no-threshold assumption in medical imaging. J Nucl Med, 2017, 58: 1014–1015. [Medline] [CrossRef]

66) Siegel JA, Pennington CW, Sacks B: Subjecting radiologic imaging to the linear no-threshold hypothesis: a non sequitur of non-trivial proportion. J Nucl Med, 2017, 58: 1–6. [Medline] [CrossRef]

67) Siegel JA, Pennington CW: The mismeasure of radiation. Debunking the flawed science that low-dose radiation may cause cancer; in fact, it may even be beneficial. Skeptic Mag, 2015, 20: 46–51.

68) Sacks B, Meyerson G, Siegel JA: Epidemiology without biology: false paradigms, unfounded assumptions, and spurious statistics in radiation science (with commentaries by Inge Schmitz-Feuerhake and Christopher Busby and a reply by the authors). Biol Theory, 2016, 11: 69–101. [Medline] [CrossRef]

69) Siegel JA, McCollough CH, Orton CG: Advocating for use of the ALARA principle in the context of medical imaging fails to recognize that the risk is hypothetical and so serves to reinforce patients' fears of radiation. Med Phys, 2017, 44: 3–6. [Medline] [CrossRef]

70) Siegel JA, Sacks B, Pennington CW, et al.: Dose optimization to minimize radiation risk for children undergoing CT and nuclear medicine imaging is misguided and detrimental. J Nucl Med, 2017, 58: 865–868. [Medline] [CrossRef]