Review Article

Structural rehabilitation of the cervical lordosis and forward head posture: a selective review of Chiropractic BioPhysics® case reports

Paul A. Oakley, DC, MSc1), Sean Z. Kallan, BSc1), Deed E. Harrison, DC2)

1) Private Practice: Newmarket, ON, L3Y 8Y8, Canada
2) CBP NonProfit, Inc., USA

Abstract. [Purpose] To characterize the case report evidence of Chiropractic BioPhysics® (CBP®) technique methods applied to increase cervical lordosis and improve forward head posture. [Methods] The CBP Non-profit website as well as PubMed and Index to Chiropractic literature were searched for case reports/series documenting the increase of cervical lordosis and improvement of forward head posture in the treatment of various craniocephal spinal disorders by CBP technique methods. [Results] Sixty patients were reported in 41 unique manuscripts detailing the improvement in cervical spine alignment by CBP technique methods. On average, there was a 14° improvement in cervical lordosis and a 12 mm reduction in forward head position after 40 treatments over 16 weeks with a 5-point reduction in pain rating scores. Thirty-eight percent of cases included follow-up showing only slight loss of lordosis, but maintenance of pain and disability improvements after an average of 1.5 treatments per month for 1.8 years. [Conclusion] An abundance of reports document improvement in craniocephal and other ailments by CBP methods that increase cervical lordosis. Routine radiographic imaging of the spine is recommended as it is safe and the only current practical method of screening for critical biomechanical biomarkers of sagittal spine alignment.

Key words: Cervical lordosis, Forward head posture, Cervical spine

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INTRODUCTION

There has been increasing interest from the spine research community of the importance of the cervical spine over the last decade1-5). Many reviews have presented common biomechanical parameters that are important in the comprehensive assessment of the cervical spine, and these can easily be quantified from radiographic imaging6). Of many craniocephal parameters, the cervical lordosis and sagittal head posture are among the most important as the lordotic shape and a neutral sagittal vertical alignment of C2 relative to C7 of the cervical spine are both important for optimizing joint loading7), maintaining cervical range of motion8), achieving a horizontal gaze9) and preserving the pons-cord tract in a normal slackened position10).

The cervical lordosis is a critical feature of early intrauterine development11), is the normal configuration in adulthood12) and can be used to discriminate between symptomatic and asymptomatic persons13). A loss of normal lordosis in the cervical spine is an important clinical predictor of poor outcomes after fusion surgery14), is associated with degenerative processes15), neck pain13, 16), headache17), myelopathies and radiculopathies18) and dizziness19).

A recent systematic review located 9 controlled trials featuring Chiropractic BioPhysics® (CBP®) methods used in the rehabilitation of the cervical lordosis (i.e. some form of cervical extension traction)20). It was determined that there were “several high-quality controlled clinical trials substantiating that increasing cervical lordosis by extension traction as part of a..."
spinal rehabilitation program reduces pain and disability and improves functional measures, and that these improvements are maintained long-term. Since this review (2020), there have emerged further supporting the clinical importance of increasing the cervical curve and reducing forward head posture in patients who present with neck related disorders concomitant with a loss of normal lordosis and forward head alignment.

CBP technique is a full-spine, spine and posture correcting method that utilizes mirror image adjusting, exercises and traction procedures, where mirror image refers to the reversing of the spine and posture into the opposite of the present- ing malalignment during the performance of rehabilitative procedures. CBP also employs unique extension traction methods which have proven effective for restoring normal lordosis and reducing forward head posture.

CBP Nonprofit (www.cbpnonprofit.com) lists all publications involving CBP methods and is updated annually; currently, there are 277 listed peer-reviewed publications. Over the years there have been many case reports documenting the clinical effectiveness of improving sagittal cervical spine alignment leading to simultaneous positive clinical outcomes in the treat- ment of various pathological conditions. As mentioned, several controlled trials have demonstrated the efficacy of CBP cervical extension traction to increase lordosis, these have been primarily on mid-aged, neck pain/radiculopathy individuals. Therefore, despite these trials there is a gap in the literature on the efficacy of CBP methods to patients varying in age and pathological condition. In fact, since the manual therapies literature is generally lacking in scientific evidential support, the case report is an important source of evidence to ‘fill the gap’ for rehabilitative therapies and specific populations which lack higher levels of scientific support (e.g. randomized clinical trial, systematic literature reviews, and meta-analyses).

The purpose of this review is to characterize the clinical evidence as specifically presented in case reports/series featuring the clinical application of CBP technique methods to increase cervical lordosis and reduce forward head posture. We further aim to highlight the varied pathological conditions treated as well as the various outcome variables documented in order to explore future types of clinical case reports that are needed to fill gaps in this type of literature.

METHODS

A review of the CBP NonProfit website citation listings was performed for clinical papers reporting on the treatment of cervical hypolordosis and forward head posture via CBP technique methods. This review was focused on only case reports and case series; therefore, no clinical trials were considered other than to use as a comparison to identified results. A thorough review of clinical trials on these methods has been published recently; thus, the current project was a system- atized literature review of clinical case reports and not a systematic review per se.

Since the CBP NonProfit website lists all the peer-reviewed CBP publications and gets updated every fall, there was a search performed in PubMed and in the Index to Chiropractic Literature (ICL) for any cases published within the last year (i.e. Oct. 2021–July, 2022). Search terms included the keywords cervical spine, cervical lordosis, forward head posture, combined with chiropractic biophysics, CBP, extension traction and rehabilitation. Any recent located cases were also screened for references related to the topic. Further, authors having multiple previous case reports were searched individually on PubMed, ICL and ResearchGate for any recent case reports involving the cervical spine.

The CBP nonprofit site lists 129 case reports/series. These were systematically searched to locate any report documenting treatment directed at improving the lordotic and sagittal alignment of the cervical spine regardless of the title and abstract. Only cases that specifically described some form of cervical ‘extension traction’ were included. Details extracted from located studies included both the age and sex of patient, primary symptomatic complaint, number of treatments, time duration of treatment, treatment specifics including traction set-up, traction duration, exercise protocol and adjusting protocol. Details of pain, disability and health-related quality of life scores as well as the biomechanical X-ray parameters of cervical lordosis, anterior head translation (AHT) and atlas plane line (APL) were also noted. The first two authors extracted details from the located articles independently and any discrepancies existing after consolidation of data were solved by consensus.

RESULTS

Sixty individual patients were reported to be treated by CBP methods to restore the cervical lordosis and/or reduce AHT as reported in 41 peer-reviewed manuscripts (Table 1). The majority of cases were located from the CBP NP website, however, 5 more cases were located from searchers on Pubmed (n=113), ICL (n=133) and ResearchGate (n=333). Not including the series by Shahar31 (reported group average only), on average, there was a 14.1° improvement in cervical lordosis after an average of 40 treatments over an average of 16 weeks. The range of ages treated were between 18–75 (average 43), the average reduction in AHT was 11.9 mm, the average increase in APL was 9.2°. The average reduction in pain rating was 4.9-points on an 11-point scale (0–10) representing an 80% average reduction in pain intensity. Of the fourteen cases that included pre-post disability scores, there was an average 38% reduction in disability over the respective patient courses of treatment; disability was usually quantified by the neck disability index (NDI).

Twenty-three cases (38% of total cases) reported follow-up outcome measures after an average maintenance treatment schedule of 1.5 treatments per month over an average of 1.8 years (range 0.25–13 years) (Table 2). There was an average loss of initial lordosis correction of 3.1°, and a maintenance within error of APL (−1.6°) and AHT (−1.6 mm). Of the cases reporting follow-up NPRS (n=10), there was on average no change (−0.1/10), or a long-term maintenance of the initial pain.
| Author | Year | Journal | Case Description | AHT | Pre-post APL | Pre-post | Pain | Other |
|--------|------|---------|------------------|-----|--------------|---------|-----|-------|
| Fortner | 2022 | JPTS | Headache | 0.25 | 25 | 2 m | f | 69 | 0.5 | 6.4 mm | 9.6 mm | −5 mm | 3 mm | 3.3 | 3.3 | Improved HDI, NDI & SF-36 | 1.1 y | 5% | 94% | 68/20 | 48 | QOL | Fortner | f | 36 | 3.75 m | −11.2°/−24° | 12.8° | −28.9°/−35.7° | 6.8° | 2.4 mm | 7.4 mm | −5 mm | 5/0.5 | 4.5 | 98%/4% | 94% | Improved symptoms/NDI/SF-36/grip strength | 1.1 y | 48 | 96% | 48 |
| Chu | 2022 | JCC | Degenerative spondylolisthesis | 0.25 | 2 | 2 m | f | 69 | 4.5 | 5.4 mm | 8.6 mm | −5 mm | 3 mm | 3.3 | 3.3 | Improved HDI, NDI & SF-36 | 1.1 y | 5% | 94% | 68/20 | 48 | QOL | Fortner | f | 36 | 3.75 m | −11.2°/−24° | 12.8° | −28.9°/−35.7° | 6.8° | 2.4 mm | 7.4 mm | −5 mm | 5/0.5 | 4.5 | 98%/4% | 94% | Improved symptoms/NDI/SF-36/grip strength | 1.1 y | 48 | 96% | 48 |
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Table 1. Details of case reports showing improved cervical lordosis in the treatment of patients with various pathological disorders.
| Author | Year | Journal | Primary complaint | Age | M/F | No. Txts | Duration | Pre-post ARA | ARA increase | Pre-post APL | APL increase | Pre-post AHT | AHT reduction | Pre-post pain | Pain reduction | Pre-post disability | disability reduction | Other outcomes | Fu time |
|--------|------|---------|------------------|-----|-----|---------|----------|------------|-------------|------------|-------------|------------|---------------|--------------|---------------|-------------------|-------------------|---------------|--------|
| Chu    | 2019 | Arch Clin Med Case Rep | Cervicogenic headache | 37 | f | 60 | 6 m | −7°/−22° | 15° | n/r | n/r | 70 | 7 | 60% | n/r | ? | Resolved headaches/neck pain off meds | 1 y |
| Dennis | 2018 | JPTS | Neck pain/ headaches | 24 | m | 24 | 2.5 m | +3°/−18.6° | 21.6° | n/r | n/r | 44.9 mm/−5.6 mm | 50.5 mm | 80 | 8 | 66%/0% | 60% | Resolution of pain, headaches | no |
| Weiner | 2018 | JPTS | Spinal stenosis | 66 | f | 78 | 6.5 m | −16.3°/−26.8° | 10.5° | −12.3°/−23.2° | 10.9° | 29.8 mm/34.9 mm | −5.1 mm | n/r | n/r | 62%/18% | 44% | Reduced radiculopathy/ pain | no |
| Former | 2018 | JPTS | Spine pain/ headaches | 32 | m | 36 | 3.25 m | −12.4°/−22.4° | 10° | +0.3°/−18.5° | 18.8° | 38.2 mm/23.1 mm | 15.1 mm | 5−8/1 | 4−7 | 38%/4% | 34% | Resolution of pains | no |
| Former | 2018 | JPTS | WAD/dizziness | 46 | m | 46 | 4 m | −17.4°/−23.2° | 5.8° | −2.8°/−12° | 9.2° | 22.1 mm/31.2 mm | −9.1 mm | 50 | 5 | n/r | n/r | Resolution of dizziness/pain/ ringing in ears | 1 y |
| Former | 2018 | JPTS | WAD | 31 | f | 30 | 5 m | −18.8°/−32.1° | 13.3° | n/r | n/r | n/r | n/r | 30 | 3 | n/r | n/r | Resolution of headaches/pain | no |
| Former | 2018 | JPTS | Advanced osteoarthritis | 38 | m | 30 | 4.5 m | −4.8°/−31.7° | 26.9° | −18.8°/−32.5° | 13.7° | 7.3 mm/3.8 mm | 3.5 mm | 4/2/4 | 1.6 | 30%/16% | 14% | Reduced disability/pain, improved QOL/blurred vision | no |
| Harrison | 2018 | JPTS | Post-surgical fusion | 52 | m | 21 | 2.25 m | −25°/−31° | 6° | +3°/−6° | 9° | 59 mm/39.5 mm | 19.5 mm | 6/1 | 5 | 18%/12% | 6% | Reduced radiculopathy/pain/ disability | 2.5 y |
| Betz | 2018 | JPTS | Exertional dyspnea | 19 | m | 37 | 3 m | −1°/−30° | 29° | −7°/−28° | 21° | 13 mm/0 mm | 13 mm | n/r | n/r | n/r | n/r | Reduced dyspnea/neck/back pain | 2.75 y |
| Wickstrom | 2017 | JPTS | Cervical radiculopathy | 31 | m | 40 | 4.25 m | +16°/−50.6° | 46.6° | n/r | n/r | 49 mm/5−5.6 mm | 54.6 mm | 6/1 | 5 | 46%/0% | 46% | Resolution of radiculopathy/ pain/disability | 1 y |
| Fedorchuk | 2017 | AVSR | Post-surgical fusion | 43 | f | 36 | 3 m | −11.1°/−23.8° | 12.7° | −11.7°/−24.6° | 12.9° | 19.8 mm/10.9 mm | 8.9 mm | n/r | n/r | n/r | n/r | Reduced pain/headaches/ improved ADL | no |
| Fedorchuk | 2017 | AVSR | Fibromyalgia | 40 | f | 44 | 5 m | +0.4°/−11.8° | 12.2° | −18°/−22.8° | 4.8° | 32.7 mm/15.4 mm | 17.3 mm | n/r | n/r | n/r | n/r | Reduced pain, improved SF-36 | no |
| Fedorchuk | 2017 | J Mol Genet Med | Dysautonomia | 35 | f | 36 | 5 m | −18.8°/−27° | 8.2° | −20.2°/−25° | 4.8° | 24 mm/17.7 mm | 6.3 mm | 5/1 | 4 | n/r | n/r | Reduced tics, off meds | 13 y |
| Oakley | 2017 | CJA | Tourette's | 19 | m | 81 | 3 m | +12°/−16° | 28° | 0°/−17° | 17° | 46 mm/24 mm | 22 mm | n/r | n/r | 40%/20% | 20% | Reduced tics, off meds | no |
| Oakley | 2017 | CJA | Unsteady gait | 75 | f | 25 | 2.5 m | −22°/−33° | 11° | −18°/−30° | 12° | 35 mm/21 mm | 14 mm | 3−6/0 | 3−6 | 42%/0% | 42% | Anti gait, resolution of pain/ disability | 0.2 y |

ADL: activities of daily living; AHT: anterior head translation; APL: atlas plane line; ARA: C2-7 absolute rotation angle; DHI: dizziness handicap inventory; GERD: gastroesophageal reflux disease; HDI: headache disability index; NBQ: neck Bournemouth questionnaire; NDI: neck disability index; ODI: Oswestry disability index; PDQ: pain disability questionnaire; QOL: quality of life; SF-36: short form-36 questionnaire; TOS: thoracic outlet syndrome; WAD: whiplash associated disorder; YGTSS: Yale global tic severity scale; *C2-7 Cobb angle.
| Author       | Year | Journal | Primary complaint               | Age | M/F | No. Txs | Ttx duration | Pre-post ARA change | ARA increase | Pre-post APL change | APL increase | AHT change | Pre-post pain reduction | Pre-post disability reduction | Other outcomes | Fu time |
|--------------|------|---------|---------------------------------|-----|-----|---------|---------------|---------------------|--------------|--------------------|--------------|-------------|------------------------|-----------------------------|---------------|---------|
| Fedorchuk    | 2016 | AVSR    | Anterolisthesis                | 52  | f   | 30      | 3 m           | −22.8°/−26°          | 3.2°         | −32.8°/−31.2°        | −1.6°        | 19.6 mm/9.0 mm | n/r                   | n/r                  | n/r             | no      |
| Bak          | 2015 | AVSR    | Hypothyroidism                 | 44  | f   | n/r     | 6 m           | −8.1°/−15°           | 6.9°         | n/r                | n/r          | 17.2 mm/13.7 mm | 3.5 mm               | n/r                  | n/r             | no      |
| Cardwell     | 2014 | AVSR    | Headaches/sinususes           | 34  | m   | 33      | 9 m           | −31°/−38°           | 7°           | n/r                | n/r          | 28 mm/0 mm        | 28 mm                | n/r                  | n/r             | no      |
| Fedorchuk    | 2014 | AVSR    | GERD                           | 27  | f   | 19      | 2 m           | −6.2°/−28°           | 21.8°        | −26.1°/−44.5°       | 18.4°        | 17.5 mm/4 mm      | 13.5 mm              | 54                  | 1 n/r           | no      |
| Jaeger       | 2014 | AVSR    | Urinary incontinence          | 63  | f   | 22      | 2 m           | −6.9°/−11°           | 4.1°         | −30.9°/−27.2°       | −3.7°        | 13.3 mm/17.7 mm   | −4.4 mm              | ?                   | n/r             | no      |
| Shapiro      | 2012 | AVSR    | Parkinson’s                    | 67  | m   | 38      | 3 m           | −24°/−39°           | 15°          | n/r                | n/r          | 28 mm/0 mm        | 28 mm                | n/r                  | n/r             | no      |
| Fedorchuk    | 2011 | AVSR    | Dyslipidemia                   | 49  | f   | ?       | 3 m           | 28.7°/−31.4°         | 2.7°         | −19.3°/−14.3°       | −5°          | 52.7 mm/35.8 mm   | 16.9 mm              | n/r                  | n/r             | no      |
| Oakley       | 2007 | JVSRS   | Post-surgical laminectomy      | 35  | m   | 36      | 3 m           | −19°/−32°           | 13°          | −16°/−23°          | 7°           | 47 mm/36 mm      | 11 mm                | 80                  | 8 n/r           | 0.75 y  |
| Haas         | 2005 | JMPT    | Syringomyelia                  | 41  | m   | 26      | 0.75 m        | −10°/−30°           | 20°          | 0°/−14°            | 14°          | 38 mm/15 mm       | 23 mm                | 8.54.5               | 4 n/r           | 1 y     |
| Ferrantelli  | 2005 | JMPT    | WAD                            | 40  | m   | 64      | 9.5 m         | −3°/−17°            | 20°          | −13°/−16°          | 3°           | 74 mm/32 mm      | 42 mm                | 50                  | 5 n/r           | no      |
| Colloca      | 2003 | JMPT    | Ehlers-Danlos syndrome         | 49  | f   | 43      | 6 m           | +9°/−2°             | 11°          | n/r                | n/r          | 12 mm/8 mm       | 4 mm                 | 53                  | 2 n/r           | 1.5 y   |
| Average      |      |         |                                |    |     | (n=47)  |                   | 4 m               | −9.1°/−23.9°       | 14°          | −14.7°/−23.3°      | 9.2°         | 27.9 mm/16.0 mm   | 11.9 mm              | 5.6/11.0             | 4.9 n/r         | 1.8 y   |
| SD           |      |         |                                |    |     | (n=47)  |                   | 4 m               | −9.1°/−23.9°       | 14°          | −14.7°/−23.3°      | 9.2°         | 27.9 mm/16.0 mm   | 11.9 mm              | 5.6/11.0             | 4.9 n/r         | (2.6 y) |
| Shahar       | 2019 | Spine   | Craniocervical symptoms        | 18–36| f | xf     | 84          | 3 m           | −8.5°/−14.5°        | 6°           | 13°/18°           | 5°           | 25 mm/19 mm       | 6 mm                 | n/r                | n/r             | no      |

ADL: activities of daily living; AHT: anterior head translation; APL: atlas plane line; ARA: C2-7 absolute rotation angle; DHI: dizziness handicap inventory; GERD: gastroesophageal reflux disease; HDI: headache disability index; NBQ: neck Bournemouth questionnaire; NDI: neck disability index; ODI: Oswestry disability index; PDQ: pain disability questionnaire; QOL: quality of life; SF-36: short form-36 questionnaire; TOS: thoracic outlet syndrome; WAD: whiplash associated disorder; YGTSS: Yale global tic severity scale; °C2-7 Cobb angle.
### Table 2. Details of the cases that reported a follow-up after the initial corrective care to restore cervical lordosis

| Author | Year | Primary complaint | Age | M/F | F/u time | F/u No. | Tx Ts | Txt freq | Post-ARA/ Post-APL/ Post-AHT/ Post-pain/ Post-Disability/ Disability | ARA dif/ APL dif/ AHT dif/ f/u pain dif/ f/u disability dif |
|--------|------|------------------|-----|-----|----------|---------|------|----------|----------------------|-----------------------------------------------|
| Fortner | 2022 | Headache | 26 | f | 2.5 y | 43 | 1/m | -36°/-33.3° | 2.7° | 9.6 mm | n/r | n/r | n/r | 16%/2% | -14% |
| Jaeger | 2022 | Total disc replacement | 38 | f | 2.5 y | n/r | n/r | -30.4°/-17.6° | 12.8° | 4.6 mm | n/r | n/r | n/r | 1/1 | 0% |
| Chu | 2022 | Cervical radiculopathy | 24 | m | 0.25 y | 6 | 2/m | -2° | n/r | n/r | n/r | n/r | n/r | 2/ | n/r |
| Chu | 2022 | TOS | 30 | m | 1 y | n/r | n/r | -35°/n/r | n/r | n/r | n/r | n/r | n/r | n/r |
| Chu* | 2021 | Cervical dizziness | 40 | m | 1 y | n/r | n/r | -10°/n/r | n/r | n/r | n/r | n/r | n/r | 0/0 | 200 |
| Berry | 2020 | Trigeminal neuralgia | 64 | m | 1 y | 24 | 2/m | -14°/-18° | -4° | 26 mm/21 mm | -5 mm | 2/ | n/r |
| Chu | 2021 | Dizziness | 57 | f | 1.83 y | n/r | n/r | -33.2°/n/r | n/r | n/r | n/r | n/r | n/r | n/r |
| Fortner | 2020 | WAD | 29 | f | 1.1 y | 8 | 2/m | -24°/-18° | 6° | 7.4 mm/11.6 mm | 4.2 mm | n/r | n/r | 4%/10% | 6% |
| Chu | 2020 | Cervical pain | 49 | f | 0.75 y | n/r | n/r | -21.5°/n/r | ? | 15.8 mm/n/r | n/r | n/r | n/r | 10%/2% |
| Spriggs | 2019 | Chronic migraine | 35 | m | 0.4 y | 7 | 1/m | -21.5°/n/r | ? | 15.8 mm/n/r | n/r | n/r | n/r | 10%/2% |
| Fortner | 2019 | Exertional dyspnea | 18 | m | 0.6 y | 4 | 1/m | -28.2°/-27.6° | 0.6° | 36.5 mm/n/r | n/r | n/r | n/r | 1/1 |
| Anderson | 2019 | Parkinson’s | 59 | m | 1.75 y | n/r | n/r | -37.2°/n/r | ? | 19.8°/n/r | n/r | n/r | n/r | 2/ |
| Chu | 2019 | Cervical headache | 37 | f | 1 y | n/r | n/r | -22°/n/r | ? | n/r/ | n/r | n/r | n/r | n/r |
| Fortner | 2018 | WAD dizziness | 46 | m | 1 y | 10 | 1/m | -23.2°/-30.4° | -7.2° | 31.2 mm/15.9 mm | -15.3 mm | 0/0 | 0/ |
| Harrison | 2018 | Post-surgical fusion | 52 | m | 2.5 y | 38 | 1/m | -31°/-30° | 1° | 39.5 mm/46 mm | 6.5 mm | 1/2 | 1/ |
| Betz | 2018 | Exertional dyspnea | 19 | m | 2.75 y | 12 | 1/m | -30°/-22° | 8° | 0 mm/4 mm | 4 mm | n/r | n/r | n/r |
| Wickstrom | 2017 | Cervical radiculopathy | 31 | m | 1 y | 24 | 2/m | -30.6°/-19.5° | 11° | 6.1 mm | 1/ | n/r | ? | 0%/ |
| Oakley | 2017 | Tourette’s | 19 | m | 1.3 y | n/r | n/r | -16°/n/r | ? | 24 mm/n/r | n/r | n/r | n/r | 20%/ |
| Oakley | 2017 | Unsteady gait | 75 | f | 0.4 y | 44 | m | -33°/n/r | ? | 21 mm,n/r | ? | 0/ | n/r | n/r |
| Fedoruk | 2011 | Dyslipidemia | 49 | f | 1.5 y | 24 | 2/m | -31.4°/n/r | ? | 35.8 mm/n/r | n/r | n/r | n/r | n/r |
| Oakley | 2007 | Post-surgical laminectomy | 35 | m | 0.75 y | 0 | 0 | -32°/-32° | 0° | 36 mm/n/r | n/r | n/r | n/r | n/r |
| Haas | 2005 | Syringomyelia | 41 | m | 1 y | 15 | n/r | -30°/-20° | 0° | 15 mm/3 mm | -12 mm | 4.54 | n/r | 0/ |
| Average (n=23) | 39.8 | 9 f | 1.8 y | 18.8 | 1.5/m | -26.0°/-24.8° | 3.1° | 20.4 mm/16.5 mm | -1.6 mm | 0.706 | -0.1 | 8.9%/5.7% | -3.8% |
| SD (n=23) | 15.0 | 14 m | (2.6 y) | (15.2) | (1.0/m) | (9.2°/6.3°) | (6.4°) | (8.6°/10.7°) | (3.8°) | (140 mm/15.7 mm) | (9.1 mm) | (12.1/4.5) | (7.8%/4.1%) | (10.1%) |

AHT: anterior head translation; APL: atlas plane line; ARA: C2-7 absolute rotation angle; DHI: dizziness handicap inventory; HDI: headache disability index; NBQ: neck Bournemouth questionnaire; NDI: neck disability index; PDQ: pain disability questionnaire; TOS: thoracic outlet syndrome; WAD: whiplash associated disorder; YGTSS: Yale global tic severity scale; *C2-7 Cobb angle. Columns calculating difference (‘dif’) indicate ‘−’ for further improvement and ‘+’ for loss of correction.
relief. Of the cases reporting follow-up disability scores (n=8), there was on average, stability of disability improvement as achieved following the initial post-treatment results. Only 3 out of the 41 (7%) manuscripts presented information on more than one case (case series) 39, 40, 71.

The cases reported positive patient outcomes for a wide range of pathological conditions not limited to craniocervical complaints. All patients did not necessarily have improvement in their presenting conditions, but all had some sort of improved outcomes (e.g. pain, disability etc; For details see Table 1). Primary conditions treated included: carpal tunnel syndrome 33, cervical disc replacement 32, cervical radiculopathy 34, cervical spondylolysis 40, 60, cervical spondylotic myelopathy 59, cervical stenosis 40, 47, dizziness 35, 37, 49, dysautonomia 73, dyslipidemia 66, Ehlers-Danlos syndrome 39, extero- tional dyspnea 42, 53, fibromyalgia 46, gait and balance instability 44, 59, gastroesophageal reflex disease (GERD) 63, headache (including migraine) 31, 41, 45, 46, 48, 62, hypothyroidism 64, neck pain (most cases), osteoarthritis 51, Parkinson’s disease 65, post-surgical fusion 52, 55, sinus problems 62, syringomyelia 68, thoracic outlet syndrome 34, Tourette’s 59, trigeminal neuralgia 46, gait dysfunction 59, urinary incontinence 64 and whiplash associated disorders 38, 49, 50, 60. Many reports also detailed improvements in cervical range of motion, disability (e.g. neck disability index), health-related quality of life (e.g. SF-36), elimination of medication use and improved sleep. There were also reports of improved asthma symptoms 42, relief of ringing in the ears 69, resolution of blurred vision 51 and in one case, telomere lengthening 57.

**DISCUSSION**

This selected literature review has summarized the details from case reports and case series documenting the improvement of cervical lordosis and forward head posture (AHT) by CBP technique methods. We located data on 60 patients as reported in 41 citations 31–71. On average, a lordosis improvement of 14° was accomplished after an average of 40 treatments over an average of 16 weeks. There was also an average 11.9 mm reduction in AHT, an average 9.2° increase in the APL and a 4.9-point reduction in pain as rated on an 11-point scale.

Importantly, there were documented improvements in a wide variety of chief complaints not exclusively attributed to neck pain and/or headaches. For example, relief was documented in reported cases of sinus problems 62, neurologic tics 58, blurred vision 51, ringing in the ears 69, dizziness 35, 37, 49, gait and balance instability 44, 59 and incontinence 64, among others. There were also structural spinal changes reported beyond lordosis and AHT changes such as reduction of cervical spondylolisthesis 40, 60, improved clivo-axial angle 53, as well as reduction of forward head translation and increased lordosis in patients having presence of partial cervical spine fusion 52, 55. One case featured the documentation of telomere lengthening after cervical lordosis and AHT improvement after 36 treatments over 5-months 73.

The summarized data indicate there is a 0.35° improvement in cervical lordosis per treatment; therefore, on average, it takes 3 treatments to create 1° of lordosis improvement. It is important to acknowledge that this is exactly on par with the results from clinical trials on these methods that show an average of 14° improvement over 30–40 treatments 20 (Table 3). Thus, a properly conducted case report may reflect the results from a carefully conducted randomized trial for these methods.

It is also important to appreciate that the cases listed in Table 1 represent a diverse population affected by varied pathological conditions. It can be cautiously concluded that extension traction methods aimed to improve the cervical lordosis and reduce AHT as part of a multimodal rehabilitation program appears to be universally successful across genders, adult age groups, and pathological complaints. Further, it appears cervical lordosis and other radiographic parameter improvements as well as the corresponding pain relief and disability improvements are stable and lasting when an average maintenance program of 2× per month is continued after the initial intensive corrective care (Table 2).

Neck pain and headache improvement after cervical spine treatment including improved radiographic sagittal plane alignment has a direct link of causation in the current literature. Harrison et al., for example, were able to differentiate symptomatic neck pain patients from asymptomatic volunteers statistically by discriminant analysis 33. In their study 33, chronic neck pain and acute neck pain sufferers had an average cervical lordosis of 22° and 28.6° (C2-7 posterior tangents), respectively. McAviney et al. determined that patients having neck curves (C2-7 posterior tangents) less than 20° had twice the likelihood of experiencing neck pain, and patients having a curve less than 0° (straight and kyphotic curves) had an 18× likelihood of experiencing neck pain 16. Also, forward head position which can occur with loss of lordosis is associated with neck pain 73.

Regarding loss of cervical lordosis and anterior head translation being linked to headache, there is accumulating evidence supporting a direct relationship 17, 73, 76. In fact, a review by Mingels et al. found that “contemporary review of neuroanatomical, biomechanical and non-nociceptive pathways, with integration of modern pain neuroscience in tension-type and cervicogenic headache, supports spinal posture as a trigger for episodic headache” 78. Specifically, they determined that poor posture can activate C1-C3 nociceptors and that “convergence with trigeminal afferents at the trigeminocervical nucleus could explain spinal headache” 78. It is consistently reported that headache sufferers have loss of cervical lordosis 73 and forward head postures 25, 76.

The data summarized in this review points to the cervical lordosis and AHT as being important biomechanical parameters (i.e. biomarkers) that may have implications for the treatment of conditions other than the common craniocervical pathologies of neck pain and headache. One plausible explanation for the biomechanical effects of cervical subluxation on the central nervous system. Any flexion (loss of lordosis) of the cervical spine causes a simultaneous elongation of the cervical spinal canal 10; in turn, an increased strain is exerted onto the ‘pons-cord tract’ which includes the spinal cord, its.

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Table 3. Summary of clinical trial details using CBP extension traction in the improvement of cervical lordosis

| Author | Year  | Condition | Exp/ control | Age (SD) | No. of texts | Duration of text | Radiographic measures | Pain intensity | Disability scores | Other outcome measures |
|--------|-------|-----------|--------------|----------|--------------|------------------|---------------------|------------------|-------------------|----------------------|
| Moustafa 2021 | Asymptomatic | E 40 (15 f) 21.5 (2.7) | 30 | 2.5 | 4.2°/18.1° | 13.9° | 17.9° | 24 mm/ | 19.1 mm | 13.9 mm | n/a | n/a | n/a | Improved amplitudes of N13, P14, N20, P27; N30 potentials and conduction time N13-N20 |
| | C 40 (17 f) 23.9 (3.1) | 30 | 2.5 | 4.2°/4.3° | 0.1° | 5.1° | 25.6 mm/ | 19.2 mm | 8.1 mm | n/r | n/r | n/r | 78.8/45.8 | 33 | 15.6 |
| Moustafa 2021 | Cervicogenic headache | E 30 (10 f) 43.1 (8) | 30 | 2.5 | 5.6°/18.9° | 13.3° | 17.7° | 25.6 mm/ | 6.4 mm | 23 mm/ | 22.7 mm | 0.3 mm | 24 mm | n/a | n/a | n/a | n/a | n/a | 79.9/47.8 | 32.1 | 67.3 |
| | C 30 (12 f) 41.9 (7) | 30 | 2.5 | 7.2°/7.1° | −0.1 | 6.1° | 27.2 mm/ | 28.7 mm | n/r | n/r | n/r | n/r | 79.9/47.8 | 32.1 | 67.3 |
| Moustafa 2021 | Chronic non-specific neck pain | E 55 (25 f) 20 (3) | 30 | 2.5 | 5.3°/20° | 14.7° | 19.4° | 36 mm/ | 11 mm | 25 mm | 20 (3) | 5.5/1.9 | 3.6 | 1.3 | 337/20.6 | 13.1 | 10.9 |
| | C 55 (26 f) 21 (4) | 30 | 2.5 | 5.8°/6.9° | 1.1° | 5.7° | 30 mm/ | 29 mm | 1 mm | 3 mm | 0.3 mm | 24 mm | n/r | n/r | n/r | n/r | n/r | n/r | 31.9/23.3 | 12.4 | 17.4 |
| Moustafa 2018 | Cervical myofascial pain syndrome | E 60 (20 f) 31.8 (8) | 30 | 2.5 | <25°/n/r | n/r | n/r | n/r | n/r | n/r | n/r | n/r | n/r | n/r | 35.7/23.3 | 12.4 | 17.4 |
| | C 60 (24 f) 31.9 (7) | 30 | 2.5 | <25°/n/r | n/r | n/r | n/r | n/r | n/r | n/r | n/r | n/r | n/r | 35.1/24 | 11.1 | 28.5 |
| Moustafa 2017 | Cervicogenic dizziness | E 36 (14 f) 49.3 (6.7) | 30 | 2.5 | 7.5°/21.2° | 13.7° | 20.9° | 35 mm/ | 0.9 mm | 25 mm | 14 mm | 5.7/3.7 | 2.0 | 1.2 | 47.5/23.2 | 24.3 | 6.9 |
| | C 36 (31 f) 50.4 (4.9) | 30 | 2.5 | 7.2°/6.7° | 0.5° | 6.2° | 32 mm/ | 33 mm | 1 mm | 35 mm | 5.9/3.6 | 2.3 | 6 | 49.8/24.2 | 25.6 | 39.2 |
| Moustafa 2017 | Cervical spondylotic radiculopathy | E 15 (? f) n/r | 30 | 2.5 | n/r | n/r | n/r | n/r | n/r | n/r | n/r | n/r | n/r | n/r | n/r | n/r | Improved kinesiology, pain, DSSEPs, flexion-extension kinematics |
| | C 15 (? f) n/r | 30 | 2.5 | n/r | n/r | n/r | n/r | n/r | n/r | n/r | n/r | n/r | n/r | n/r | Improved kinesiology, pain, DSSEPs, flexion-extension kinematics |
| Moustafa 2016 | Cervical discogenic radiculopathy | E 30 (11 f) 41.5 (3.7) | 30 | 2.5 | 6.5°/19.7° | 13.1° | 19.2° | 25.4 mm/ | 13.0 mm | 15.1 mm | 5.1/3.3 | 3.8 | 0.5 | 20.2/7.7 | 12.5 | 0.1 |
| | C 30 (12 f) 43.9 (6.2) | 30 | 2.5 | 6.5°/6.7° | 0.2° | 6.8° | 24.4 mm/ | 24.1 mm | 4.7/1.2 | 1.3 | 4.7 | 20.6/12.9 | 7.7 | 20 |
| Moustafa 2013 | Fibromyalgia | E 40 (10 f) 54.3 (7) | 36 | 3 | 6.6°/19.4° | 12.8° | 18.3° | 27.9 mm/ | 14.5 mm | 14.9 mm | 5.2/3.2 | 2.0 | 2.9 | 70.9/44.1 | 26.8 | 9.3 |
| | C 40 (12 f) 52.2 (6) | 36 | 3 | 7.5°/7.2° | 0.4° | 5.5° | 27 mm/ | 19.1 mm | 7.9 mm | 21.2 mm | 4.6/3.1 | 1.5 | 4.7 | 71.3/34.6 | 27.7 | 47.9 |

RCT: randomized controlled trial; nRCT: non-randomized controlled trial; AHT: anterior head translation; f/u: follow-up; E: experimental group; C: control group.
| Author | Year | Condition | Exp/ control | n | Age (SD) | No. of txts | Duration of txt | Pre-post lordosis | AHT reduction | Pre-post AHT | Pain reduction | Pre-post disability | Disability reduction | Post-treatment & long-term treatment grp & f/u | Other outcome measures |
|--------|------|-----------|--------------|---|----------|-------------|----------------|-------------------|---------------|-------------|----------------|--------------------|----------------------|-----------------------|---------------------|
| Harrison 2003 | Chronic neck pain | E | 33 (14 f) | 36.0 (14.2) | 38 | 3.75 m | 4.2°/ 22.1° | 17.9°/ 22.0° | 24.9 mm/ 15.4 mm | 9.5 mm | 15.0 mm | 4.1/1.1 | 3.0 | n/r | n/r | n/r | n/r | 14 m |
| Harrison C | 0 | 37.0 (11.3) | 0 | n/a | 10.2°/ 11.1° | 0.9°/ n/r | 23.1 mm/ 22.4 mm | 0.8 mm | n/r | 3.5/3.4 | 0.1 | n/r | n/r | n/r | n/r | 8.5 m |
| Harrison 2002 | Chronic neck pain | E | 30 (25 f) | 33.1 (14.3) | 35 | 2.25 m | 12.4°/ 26.6° | 14.2°/ 22.9° | 22.1 mm/ 15.9 mm | 6.2 mm | 15.3 mm | 4.3/1.6 | 2.7 | n/r | n/r | n/r | n/r | 15.5 m |
| Harrison C | 0 | 35.0 (13.9) | 0 | n/a | 9.9°/ 10.8° | 0.9°/ n/r | n/r | n/r | n/r | 3.6/3.8 | −0.2 | n/r | n/r | n/r | n/r | 8 m |
| Harrison 1994 | n/s (hypolordosis) | E1 | 35 (11 f) | 3.5 (10.9) | 60 | 3 m | 14.5°/ 27.7° | 13.2°/ n/r | 19.5 mm/ 12.7 mm | 6.8 mm | n/r | n/r | n/r | n/r | n/r | n/r | n/r | n/r | Reliability assessment of X-ray markings by 3 examiners | none |
| Harrison E2 | 30 (20 f) | 3.5 (12.5) | 60 | 3 m | 18.7°/ 19.9° | 1.2°/ n/r | 21.3 mm/ 19.3 mm | 2.0 mm | n/r | n/r | n/r | n/r | n/r | n/r | n/r | n/r | 8 m |
| Harrison C | 30 (17 f) | 3.4 (11.1) | 0 | n/a | 18.2°/ 21.2° | 2.9°/ n/r | 20.9 mm/ 20.4 mm | 0.5 mm | n/r | n/r | n/r | n/r | n/r | n/r | n/r | n/r | none |

RCT: randomized controlled trial; nRCT: non-randomized controlled trial; AHT: anterior head translation; f/u: follow-up; E: experimental group; C: control group.
nerve roots as well as the brainstem including cranial nerves V-XII\(^77,78\). Under these conditions, normal physiologic tension within the spinal cord may exceed some threshold where normal movements of the head and neck (e.g. flexion) will exert pathologic tension onto the cord, impeding (slowing or altering) its neuro-conduction directly and/or indirectly by limiting its blood flow\(^10,77,78\). Thus, this ‘dynamic strain’ may elicit symptoms consistent with various disease states including radiculopathies, myelopathies, dizziness\(^79\) or contribute to poor sensorimotor control\(^80\) and affect balance, gait and other activities of daily living. In support of this mechanical tension phenomenon of altered spinal cord function, Moustafa et al.\(^21\) recently, using somato-sensory evoked potentials, identified that correction of cervical lordosis and reduction of AHT was linearly related to increased central conduction speed (spinal cord velocity); results were maintained at a 3-month follow up.

Since the diagnosis of alterations of cervical lordosis is not widely recognized by the medical community\(^81\) and due to the fact that many manual therapists do not routinely X-ray their patients, many patients will not be appropriately biomechanically diagnosed with cervical spine subluxation and therefore, their spine deformity will not be treated and it will persist despite short-term relief from ‘black-box treatment’ procedures\(^20,26\). In fact, as discussed recently\(^20,26\), the Moustafa trials have exposed the trend that many physiotherapeutic treatments that provide temporary pain relief fail to provide lasting benefits; in other words, the patients’ pain levels regress towards baseline after treatment cessation. Alternatively, patients who receive treatment that includes a form of extension traction to restore lordotic alignment and reduce AHT, who present with hypolordosis, experience relief of symptoms that remains up to 2 years\(^22\). This trend points to the cervical lordosis and sagittal postural alignment as being important biomechanical biomarkers in those who suffer from cranio cervical disorders, as has been suggested in the treatment of headaches\(^33\), dizziness\(^37\) and whiplash associated disorders\(^50\).

There are limitations to this review. The fact that we included only case studies/series in this review, dictated that no statistical analysis could be performed other than simple averages. Also, the case studies documented real clinical practice and therefore, multiple treatments were performed concurrently on the patient. This conceals which specific aspects of the treatment regimen contributed to the improvement in lordosis, reduction in AHT, and also to the relief of the patient. As previously mentioned, and discussed elsewhere\(^26\), the series of randomized trials by Moustafa and colleagues has proven that targeted cervical extension traction results in lordosis and AHT improvements as well as long-lasting symptomatic relief in patients despite discontinuing treatment.

Further limitations include the distinction between primary conditions treated versus clinical outcomes achieved. For instance, a patient with osteoarthritis of the cervical spine may have had a successful outcome (i.e. improved lordosis, less pain) but remains osteoarthritic (i.e. Fortner et al.\(^49\)). Alternatively, many patients did have improvement or ‘cure/remission’ to their primary complaint, for example Breton et al.\(^49\) (carpal tunnel syndrome), Fortner et al.\(^49\) (Dizziness), etc; these distinctions must be carefully determined from studying the Table 1—‘Other outcomes’. Obviously, caution should be taken to not assume a long-term resolution of the patient condition particularly when no follow-up was reported. Last, since this review simply summarized reports using averages, cautious interpretation of results are suggested, particularly as these cases are not ‘controlled’ as in higher evidential controlled trials.

Future case reports describing CBP protocols used to increase cervical lordosis and reduce AHT should ensure use of standardized symptom, disability, and functional rating scales, fully describe the traction method and other treatment procedures and include a follow-up period of at least 6-months to a year. Cases should also report all radiographic measurements including lordosis, anterior head translation and atlas plane line. Further, future cases should also characterize the cervical lordosis in relation to both the T1-sagittal slope and to the thoracic inlet morphology which is a unique anatomical variable known to influence the amount of cervical lordosis that a given spine can achieve. The thoracic inlet morphology and T1-slope relative to the cervical lordosis are known alignment variables that predict initial and post treatment outcomes. In fact, no CBP case reported a modification to the cervical lordosis goal of care in order to provide a patient-specific customization from the default ‘ideal’ curve\(^82,83\). This is perhaps the most significant criticism of more recent case reports. Last, future cases should report on 3–10 consecutive patients with the same condition, the same general age and gender, and follow the same protocols and procedures; this would make the outcomes more meaningful having greater evidential impact.

**Conflict of interest**

Dr. Paul Oakley (PAO) is a paid consultant for CBP NonProfit, Inc.; Dr. Deed Harrison (DEH) teaches chiropractic rehabilitation methods and sells products to physicians for patient care as used in this manuscript.

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