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Case Study

Anterior head translation following cervical fusion—a probable cause of post-surgical pain and impairment: a CBP® case report

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Abstract. [Purpose] To present the case of the dramatic reduction in pain, disability, and neurologic symptoms following the reduction of forward head translation and increased cervical curvature in a patient suffering from post-surgical radiculopathy. [Subject and Methods] A 52-year-old male mechanic presented with chronic neck pain, unilateral paresthesia along the C5 and C6 dermatome distributions and diminished unilateral grip strength for 12 years following a C5–C6 cervical discectomy and fusion. Outcome measures included the neck disability index, the numerical pain rating scale, and the Zebris cervical range of motion system. Radiographs and computerized posture analysis revealed excessive forward head posture. Initial traditional 'symptom-relief' chiropractic rehabilitation was provided, followed by CBP® structural rehabilitation of head and neck posture with a 2.5 year follow-up. [Results] The initial traditional chiropractic rehabilitation did not improve posture or disability scores. CBP methods resulted in radiograph-verified postural alignment improvements corresponding with clinically significant improvements in the patient's neurologic condition, pain and disability scores. These results were maintained at a 2.5 year follow-up with minimal treatment. [Conclusion] Patients with post-surgical axial symptoms and/or radicular complaints should be screened for altered cervical alignment and anterior head translation. Future studies should attempt to duplicate these positive results in a trial with long-term follow-up.

Key words: Cervical fusion, Forward head posture, CBP

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INTRODUCTION

The point prevalence of neck pain is between 7–40% with a lifetime prevalence of 71%[1)]. The average annual incidence of cervical radiculopathy is 0.1 per 1,000 (0.01%)[1)]. Collectively, chronic spinal pain and radiculopathy unresponsive to conservative treatment are the most common reasons for surgical intervention[2)].

Problematically, a significant number of cervical spine post-surgical patients experience a negative outcome of persistent axial pain (19–38%) and extremity numbness or weakness (26%)[2–4)]. Several theories have been put forth for probable causes of these types of post-surgical impairments, including: 1) failure to obtain a stable fusion; 2) subsidence (collapse into the superior endplate of the inferior vertebra) of the fused segment; 3) adjacent segment degenerative disc disease; 4) hyper-mobility of adjacent segments; 5) kyphotic alignment of the fused segments[2–5)].

In the lumbar spine, anterior translation of the thoracic spine has been shown to correlate to poor-outcomes after lumbar fusion[6–8)]; thereby leading to sagittal alignment pre-surgical considerations[9)]. More recently, efforts to establish similar pre-surgical alignment recommendations for the cervical spine have emerged[10, 11)].

The post-surgical cervical lordotic alignment is critical to prevent neurologic symptoms[3, 12, 13)], as is the sagittal head and

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cervical spine alignment[10, 14]. Tang et al.[14] found that the severity of disability increases with positive cervical malalignment following fusion surgery. They determined a critical threshold of 40 mm, beyond which the correlations of disability and forward head posture were most significant. Ajello et al.[10] determined that post-surgical forward head posture that is less than 25 mm was associated with positive outcomes.

To our knowledge, anterior translation of the head and upper cervical spine has not been investigated for its non-surgical reduction following surgery to treat lingering axial and radicular symptoms. The present case describes the simultaneous reduction in forward head posture and pain and disability impairment in a patient suffering from post-surgical axial symptoms and hand numbness/weakness treated with Chiropractic Biophysics® (CBP®) technique structural rehabilitative methods.

SUBJECT AND METHODS

In the summer of 2004, a 62-year-old male presented to the lead author's spine clinic seeking treatment for neck pain, numbness and tingling in the right antero-lateral forearm, and right arm weakness. His occupation was a diesel mechanic and his condition was reported to interfere with his ability to work due to the inability to grasp and use tools with his right hand. The patient's past history revealed previous cervical spine surgical intervention for a C5–C6 instability, vertebral spondylosis, and disc herniation. His initial cervical spine surgery was in 1991, where C5–C6 was fused using an autologous iliac crest bone graft. In 1992, the patient reported that this first surgery failed to stabilize the C5–C6 joint and a second surgery was performed using an anterior plate in addition to the autologous bone graft at C5–C6. Since 1992 the patient has suffered from post-surgical axial symptoms and radicular signs.

The male was 172.7 cm in height and weighed 83.9 kg. Cervical spine pain was diffuse, being bilateral extending from C4–T4 with pain, tenderness, and myofascial spasms identified with spinal palpation. A reduced sensation was identified on the right forearm at the C5–C6 dermatome. The brachioradialis reflex was hypo-active with right-sided weakness in grip strength.

The patient was administered the numerical rating scale (NRS) for neck pain intensity (0=no pain; 10=incapacitated due to pain)[15], where he rated his pain as 6/10. The neck disability index (NDI)[16] indicated an 18% disability (Table 1).

For functional evaluation, the patient's cervical spine range of motion (CROM) was assessed using the Zebris sonic range of motion equipment (www.zebris.com). All cervical rotational ranges of motion were significantly reduced for the patient's age[17] (Table 1).

A computerized postural analysis and cervical spine radiographs were performed for a structural evaluation. The PosturePrint® system provided by Biotonix (Montreal, Quebec, Canada) was utilized to assess the patients 3-D posture. Although this system uses three two-dimensional photographs (an anterior to posterior, a right lateral, and a left lateral), the computer uses a complex algorithm to reconstruct the estimated three-dimensional rotations and translations of the head, thorax, and pelvis. The PosturePrint's algorithms have been found to be accurate to within 2 mm for translations and 2° for rotations, when compared to known rotations and translations of a mannequin's postural components[18, 19]. The patient was found to have significant anterior translation of the pelvis relative to the feet (+TzP), anterior translation of the head relative to the thorax (+TzH), and head flexion (+RxH).

Lateral cervical, flexion and extension, and anterior-posterior cervical radiography was performed. Notably, the anterior plated and grafted fusion was found to be stable on flexion and extension movement. The lateral cervical radiograph was assessed using CBP® technique methods where segmental and total curvature was analyzed with the Harrison posterior tangent (HPT) method and anterior translation of C2 relative to C7 was measured[20–22] (Fig. 1; Table 2). These measurements were performed by the PostureRay computerized analysis system (Trinity, FL, USA).

The patient was treated with traditional chiropractic 'functional relief care' techniques for the initial 10 visits. These treatments included: 1) spinal adjustments directed to the non-fused segments of the cervical spine and upper thoracic spine; adjustments were performed by hand and with the Impulse™ hand held adjusting instrument[23] (www.neuromechanical.com); 2) general stretching into the rotational ranges of motion of the cervical spine; 3) focused myofascial therapy directed to the cervical and thoracic spine; 4) cryotherapy of the cervical and thoracic regions following the above three treatment methods. Following these 10 treatments, a re-evaluation was performed and included all previous evaluations except radiography.

After this re-evaluation, 'structural rehabilitative care' using CBP technique methods[24, 25] was performed lasting for an additional 11 visits. These methods included: 1) mirror image® postural adjustments using the PCT drop table (www.posturalcorrectiontools.com) and the Impulse adjusting instrument; 2) mirror image exercises; 3) mirror image cervical spine extension traction[25]. Following these 11 treatments, a re-evaluation was performed and included all initial questionnaires, posture evaluation, lateral cervical radiograph, and CROM. This study received IRB approved waiver of informed consent through IntegReview IRB (www.integreview.com) on August 30, 2017 (protocol No. CBP2017-002).

RESULTS

After the initial 10 treatments of 'functional relief care,' the NRS score decreased to a 2/10, however, the sagittal posture was not improved, the NDI disability increased to 22% and the CROM was not improved (Table 1).

Notably, after the 11 treatments of 'structural rehabilitative care' using CBP technique, all variables showed clinically

Table 1. Initial, 1-month, 2-month, 6-month, and 2.5 year follow-up assessment results for number of treatments, NRS, NDI, and CROM

Variable	Initial exam 7-21-04	1st re-exam 8-18-04	2nd re-exam 9-27-04	6-month f/up 1-15-05	2.5-year f/up 3-12-07
#Treatments since last/total	0	10/10 Relief visits	11/21 Corrective visits	8/29 2/mnth	30/59 1.15/mnth
NRS	6/10	2/10	1/10	1/10	2/10
NDI	18%	22%	12%	10%	8%
CROM					
Ext (−RxH)	32°	32°	44°	N/R	N/R
Flex (+RxH)	48°	50°	50°		
L Rot (+RyH)	23°	27°	23°		
R Rot (−RyH)	69°	59°	63°		
R Lat Bend (+RzH)	27°	23°	34°		
L Lat Bend (−RzH)	31°	27°	28°		

NRS: numeric rating scale; NDI: neck disability scale; CROM: cervical range of motion; f/up: follow-up; N/R: not reported.

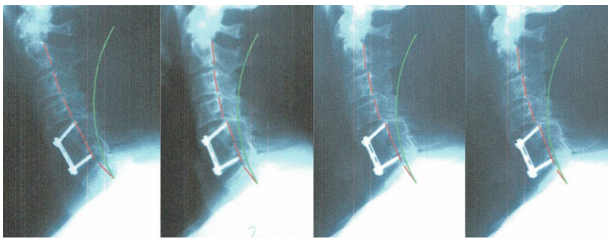

Fig. 1. Initial and follow-up lateral cervical radiographs. A: 7-21-04; B: 9-27-04; C: 1-15-05; D: 3-12-07. Note at C5–C6 the evidence of an anterior plate and autologous iliac crest bone graft. The green line represents ideal cervical lordosis, the red line highlights patient.

Table 2. Initial, 2-month, 6-month, and 2.5 year follow-up assessment results for radiographic parameters.

Variable	Normal values[41, 42]	Initial exam 7-21-04	2nd exam 9-27-04	6-month f/up 1-15-05	2.5-year f/up 3-12-07
ARA C2–C7*	−34–42°	−25°	−31°	31°	−30°
TzH**	0–15 mm	59 mm	39.5 mm	46 mm	46 mm
APL***	−24–29°	3°	−6°	−4°	−4°
RRA C2–C3+	−7–9°	−2°	−3°	−4°	−4°
RRA C3–C4+	−6–8°	−3°	−4°	−7°	−6°
RRA C4–C5+	‘−6–8°	−8°	−12°	−9°	−9°
RRA C5–C6+	‘−6–8°	0°++	0°++	0°++	0°++
RRA C6–C7+	‘−6–8°	−12°	−12°	−11°	‘−11°

*ARA: Absolute rotation angle between posterior vertebral body tangents on C2 and C7. Negative values indicate spinal extension.
**TzH: Forward head translation distance: Horizontal distance of C2 posterior-superior body corner to posterior-inferior body corner of C7.
***APL: Atlas plane line: Angle between estimated cross-section of C1 to horizontal (negative indicates backward rotation compared to horizontal).
+ RRA: Relative rotation angle (segmental angle between posterior tangents). Negative values indicate spinal extension.
++ The C5–C6 segment is the one that is fused in this patient and no movement is possible.

significant improvements: CROM was improved 12° in extension and 7° in lateral bending, NDI decreased to 12%, NRS decreased to a 1/10, forward head translation decreased, and the C2–C7 cervical lordosis increased (Tables 1 and 2).

After the 21 treatments, the patient's brachioradialis reflex was normal as was the C5–C6 dermatome sensation. The patient stated: "Now I'm sore in the morning when I get up, but before, the pain used to get me up several times during the night." Further, the patient reported an increased capacity to work and increased grip strength. The patient returned to work and agreed to continue treatment on a twice a month basis and the treatment methods included a combination of all previous interventions.

Following 4-months of treatment, a further 8 visits (29 overall treatments), a follow-up re-evaluation was performed (Tables 1 and 2; Fig. 1). His health status and outcome measures were maintained with only a small loss of the initial correction of forward head posture (6.5mm). The patient reduced his frequency of treatments to one treatment per month. Following 26-months of this care (30 treatments using a combination of all previous interventions; 59 treatments overall), the patient returned for a final follow-up evaluation (Tables 1 and 2; Fig. 1). Again, his improved health status was maintained. The patient consented to the publication of his radiographs and treatment results.

DISCUSSION

This report demonstrates the positive effects of both relief care and corrective care in a patient suffering from post-surgical pain and impairment. Notably, the initial relief care (10 treatments) resulted in improvement of the patient's subjective complaints on the NRS only, but not on the NDI nor in CROM. After the subsequent treatments incorporating CBP structural rehabilitative care (11 treatments), there was improvement in all measures, NRS, NDI, as well as increased flexibility, (12° in extension) corresponding with structural improvements of decreased forward head translation, and increased cervical lordosis (Fig. 1).

At long-term follow up, continuing 'maintenance' treatments at 1–2 per month, the 4-month, and 2.5 year check-ups revealed that the patient remained well symptomatically as well as the structural changes in reduced forward head posture and increased cervical lordosis remained stable.

The structural results in this case are consistent with that of clinical trials of extension traction[26–29] that found long-term stability in cervical curve correction after 1–1.3 years. This case was also consistent with these trials in that with structural improvement of increasing lordosis and decreasing forward head posture, a decrease in pain and disability occurred[26–29].

In one trial, Moustafa et al.[26], demonstrated that increasing the lordosis in patients with cervical radiculopathy showed decreased arm and neck pain, decreased disability, as well as improvement in amplitude and latency of dermatomal somatosensory evoked potentials (DSSEPs), as well as improved central somatosensory conduction times (N13–N20). In comparison, their control group who got 'standard' physiotherapy care, not receiving cervical extension traction, showed initial improvement in pain (at 10-weeks), but then long-term (1 year) had a digression towards baseline, whereas, the treatment group receiving extension traction, had their improvements maintained at one year. The authors[26] speculated that the improved cervical lordosis and reduced forward head posture contributed to the long-term positive outcome.

Research has indicated that anterior head posture contributes to and/or has strong correlation to neck and upper back pain[30–32], chronic headaches[33–36], cervical muscle weakness[33], thoracic outlet and radicular symptoms[37–39], reduced cervical spine range of motion (CROM)[35, 36, 39, 40], as well as disability[32].

The normal cervical spine has been modeled to be circular in shape with a range of 31–42° of extension as measured by the HPT method from C2–7 as being 'normal'[41–44]. Anterior head translation should be less than 15 mm to be considered in the 'normal' range[41]. When the head is forward in the 'neutral' position, the cervical spine is known have lower cervical flexion and upper cervical extension[45]. It is easy to conceive that this malposition/subluxation of the cervical spine will exert abnormal stresses and strains onto the spinal tissues which then may elicit nociceptive tendencies to create a potential barrage of potential symptoms.

Fernandez et al. [35], for example, determined that forward head translation correlated to more headache parameters and proposed that this forward head position causes contraction of the suboccipital muscles and contributes to the origin or perpetuation of chronic tension-type headache.

In this case, the patient had a C5–C6 surgical fusion, which obviously would interfere with the normal spinal coupling patterns with a forward head position leading to an incongruent match between what the tissues would normally do to in an attempt to accommodate poor posture and the inability for natural spinal coupling to occur. The fusion of C5–C6 in this patient was not in an extended position of 7–9° as recommended by Harrison et al. [43], but straight in alignment. This would then force the other mobile joints to 'take up the slack' in terms of spinal coupling to allow the head to be in the forward position and thus could add further stressing of particular joints and tissues in the cervical area leading to the pain and functional limitations seen in this patient.

The forward head position and hypolordosis in the cervical spine, as seen in this case, leads to a lengthening of the spinal canal and traction effect on the spinal cord[46]. The radiculopathy in this case was also likely due to posture; this would explain why when the posture improved with CBP and cervical extension traction, the disability in our patient improved, whereas, only pain and not the disability measures improved after 'relief care.' We therefore, speculate that anterior head translation and cervical hypolordosis was the primary cause of the patient's post-surgical pain and impairment.

As stated by Moustafa et al.[26] 'in populations with discogenic cervical radiculopathy, loss of cervical lordosis, and forward head posture that can tolerate extension positions, it would seem of value to conservatively restore cervical alignment as a first line of management.' As a patient presenting with failed cervical discectomy and fusion, we contend by the outcome in this case, that it is not too late to restore the head and neck alignment and propose that better long-term outcomes can still be achieved treating these patients. The relevance of this case highlights the fact that manual therapists who are presented with post-surgical patients having anterior head translation and cervical hypolordosis should incorporate methods involving the correction of these deformities to improve their patient outcomes.

A limitation to this case is that it is only a single case (n=1). Further, no x-ray was performed between the initial 'symptomatic' treatments (initial 10 treatments) and when the patient transitioned to do 'corrective' care incorporating CBP methods. This is because the treatment of spinal manipulative therapy has not routinely been associated with structural changes in the spine[29, 47–49].

Conflict of interest

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

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