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Review Article

Restoring lumbar lordosis: a systematic review of controlled trials utilizing Chiropractic Bio Physics® (CBP®) non-surgical approach to increasing lumbar lordosis in the treatment of low back disorders

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Abstract. [Purpose] To systematically review controlled trial evidence for the use of lumbar extension traction by Chiropractic BioPhysics® methods for the purpose of increasing lumbar lordosis in those with hypolordosis and low back disorders. [Methods] Literature searches were performed in Pubmed, PEDro, CINAHL, Cochrane, and ICL databases. Search terms included iterations related to the lumbar spine, low back pain and extension traction rehabilitation. [Results] Four articles detailing 2 randomized and 1 non-randomized trial were located. Trials demonstrated increases in radiographic measured lordosis of 7–11°, over 10–12 weeks, after 30–36 treatment sessions. Randomized trials demonstrated traction treated groups mostly maintained lordosis correction, pain relief, and disability after 6-months follow-up. The non-randomized trial showed lordosis and pain intensity were maintained with periodic maintenance care for 1.5 years. Importantly, control/comparison groups had no increase in lumbar lordosis. Randomized trials showed comparison groups receiving physiotherapy-less the traction, had temporary pain reduction during treatment that regressed towards baseline levels as early as 3-months after treatment. [Conclusion] Limited but good quality evidence substantiates that the use of extension traction methods in rehabilitation programs definitively increases lumbar hypolordosis. Preliminarily, these studies indicate these methods provide longer-term relief to patients with low back disorders versus conventional rehabilitation approaches tested.

Key words: Low back pain, Spine traction, Lumbar lordosis

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INTRODUCTION

The physiologic lumbar lordosis (LL) is essential for normal biomechanical functioning including spinal coupling (i.e. locomotion) and spinal load distribution (i.e. injury mechanisms)[1–5]. Its quantification in the literature has been ongoing due to the limited number of research groups investigating normal lumbar spine alignment, the lack of consistent measurement methods, and the inconsistent use of anatomical reference points of measurement[6]. The fact is, seemingly inconsistent lumbar lordosis measurements from several x-ray studies on normal populations[7–12] were found to be consistent upon close inspection of the intersegmental values[6], such that the lumbar spine was shown to represent an elliptical configuration[13, 14] (Fig. 1).

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Recently, many systematic reviews have also reached a consensus regarding the necessity of the normal lumbar lordosis and its association with low back pain (LBP). For example, in a systematic review of 13 studies (with meta-analysis), Chun et al. demonstrated the literature showed a 'strong' relationship between decreased LL in LBP patients versus asymptomatic matched controls[15]. Likewise, Sadler et al., in a systematic literature review including 12 studies representing 5,459 individuals, concluded that loss of the LL was a statistically significant predictor of LBP requiring intervention[16]. The strength of this study was that they only included studies with prospective cohorts followed for a minimum of 12-months.

Recent advances in manual therapy traction methods by the Chiropractic BioPhysics® (CBP®) group have shown that non-surgical rehabilitation of the lumbar lordosis is possible; for example, as presented in several case reports[17–20]. CBP methods is a full-spine and posture correcting technique (www.idealspine.com); however, for the purposes of this review we will focus on its employment of the unique 'extension traction' targeted to the lumbar spine in patients presenting with lumbar spine hypolordosis with various low back disorders. In the first ever clinical trial on these methods, Harrison et al. stated in a 2002 paper: "*This new method of lumbar extension traction is the first nonsurgical rehabilitative procedure to show increases in lumbar lordosis in chronic LBP subjects with hypolordosis"*[21].

Lumbar extension traction (LET) is classically a type of 3-point bending load application (Fig. 2). As described by Harrison[21], to achieve the 3-point bending, a padded strap is placed under the subject's low back at the level most deviated from normal/ideal alignment (sitting and standing positions are also possible). This 'pulling strap' is placed under tension (to patient's tolerance) and is a transverse force. When supine, the weight of the body provides the second (upper) point in the 3-point bending, overwise a strap is placed across the chest pulling posteriorly (for seated and standing positions). The third point of the 3-point bending is a strap placed at the level of the femur heads, which allows the pelvis to rotate over the femur heads. Typically, this traction is maintained for 10–20 minutes.

Since the lifetime incidence of LBP is very high (i.e. 80%[22]), and because LBP is a worldwide leading contributor to disease burden[23], an effective treatment intervention for those with hypolordosis-induced LBP would be welcomed. The purpose of this article is to perform a systematic review on the clinical controlled trials implementing CBP LET methods in the treatment of low back disorders.

METHODS

This study assessed clinical controlled trials utilizing CBP's extension traction methods to increase lumbar lordosis for the treatment of patients with low back disorders. The inclusion criteria included: (a) both randomized controlled trials (RCTs) and non-randomized controlled trials (nRCTs); (b) only trials that radiographically assessed LL; (c) only trials that applied interventions to increase LL; (d) only trials that treated patients with any type of LBP disorder. Exclusion criteria were any citations that were reviews, conference papers, surgical or animal studies, or trials not treating the low back. We adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline[24].

All RCTs were assessed for methodological quality using the 10-point PEDro scale[25–27]. All studies were assessed for risk of bias using the Scottish Intercollegiate Guidelines Network (SIGN 50) checklist for RCTs[28]. All scoring of study quality

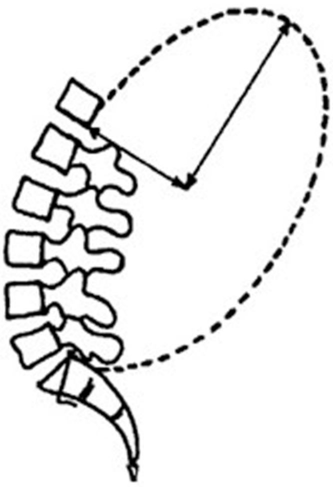

Fig. 1. Lumbar lordosis modeled as a portion of an ellipse. Biomechanical studies show consensus for an elliptical lumbar spine alignment[6].

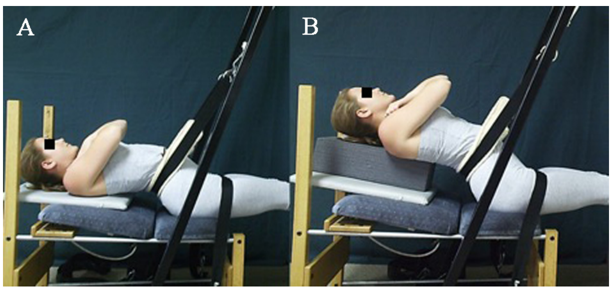

Fig. 2. Supine lumbar extension traction (LET) methods as originated by Harrison et al[40, 41]. In A, the supine method is shown where the patient has little translation of the torso relative to the hip axis. In B, supine with considerable anterior translation of the torso relative to the hip axis is shown. This setup creates anterior sagittal balance for mirror image® LET positions to correct spines showing a net posterior sagittal torso alignment. There are variations of LET setups and positions including seated and standing methods, not shown.

and bias were performed by the first two authors. In the occurrence of any discrepancies, consensus was achieved by all authors.

The literature was reviewed using the following databases: PubMed, PEDro (Physiotherapy Evidence Database), CINAHL (Current Index to Nursing and Allied Health Literature), Cochrane, and ICL (Index to Chiropractic Literature). Searches were performed from each database inception date to March 25, 2019. Key words used in literature searches included varied combinations of terms associated with the anatomical region, anatomically related pathology, traction rehabilitation methods as well as achieving lordosis restoration. Search terms included 'lumbar spine', 'lumbar lordosis', 'low back', 'pain', 'disc herniation', 'sciatica', 'radiculopathy', 'traction', 'extension traction', 'restoration', 'correction', 'increase', and 'rehabilitation'. Any located citations were also screened for references. Only articles of English language were included.

Located articles were independently assessed by the first two authors. Studies were reviewed to extract data relating to participant age, traction set-up, treatment duration, number of treatment sessions, treatment frequency, concurrent rehabilitation procedures, pain, disability or functional ability scale scores and lumbar lordosis measurements. All pertinent data were extracted for baseline, post-treatment and any follow-up assessments.

RESULTS

There were 574 initially identified articles from the five databases (Fig. 3). After removing duplicates, 90 citations were removed (n=484 remaining). After screening titles and abstracts for irrelevant topics, an additional 274 citations were removed (n=210 remaining). Upon screening for inclusion criteria, there were 4 individual citations identified outlining the results from 3 unique trials, 2 RCTs[29–31)] and 1 nRCT[21)]. The trials involved a total of 120 intervention patients suffering from chronic LBP (n=88) or discogenic radiculopathy (n=32) and 102 controls who either received no treatment (n=30) or similar treatment less extension traction (n=72). The extracted data from the trials is shown in Table 1.

The quality of the RCTs was high (7/10) according to the PEDro quality assessment scale (Table 2). Risk of bias was also good being generally low for all trials according to the SIGN 50 criteria (Table 3). The description of the three trials are as follows.

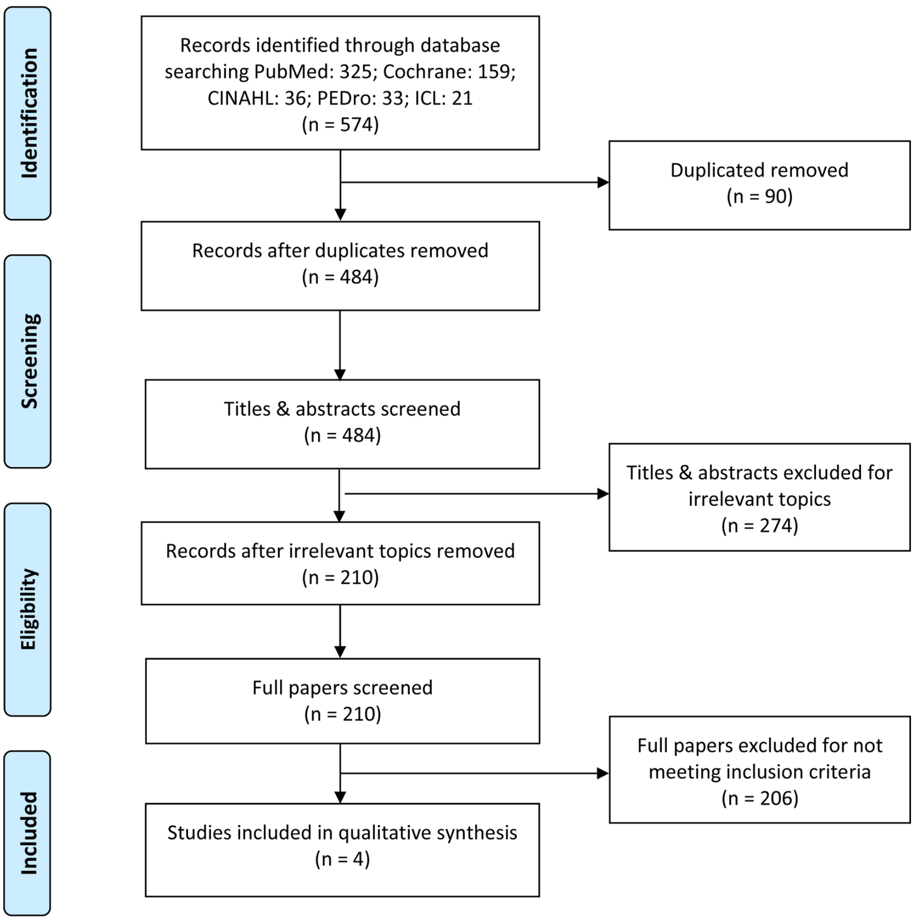

Fig. 3. Flow diagram of searched, screened, and included studies.

Table 1. Summary of 1 non-randomized, and 2 randomized controlled trials on CBP lumbar extension traction (LET) methods used to treat low back pain and lumbar disk herniation in patients with lumbar spine hypolordosis

Publication details			Cohort & treatment details						Radiographic measures			Pain intensity			Disability scores			Other outcome measures	
Author	Year	Journal	Primary complaint	Exp/ Con-trol	n	Age (SD)	No. Txts	Duration of txt	Pre-post lordosis	Lordosis increase	f/u lordosis	Pre-post LBP	Pain decrease	f/u LBP	Pre-post ODI	ODI de-crease	f/u ODI	Post-treatment & long-term treatment grp improvements in other outcome measures	F/u time
Diab (RCT)	2012/	JMPT/	Chronic LBP	E	40 (18f)	46.3 (2.0)	30	2.5 m	13.9°/20.1°	6.2°	18.3°**	6.0/3.2	2.8	1.5*/2.6**	32.4/21.8	10.6	23.8**	Improved inter-vertebral movement,	3/6 m
	2013	JBMR		C	40 (17f)	45.9 (2.1)	30	2.5 m	13.7°/15.2°	1.5°	14.7°**	5.5/3.5	2.0	4.5*/3.5**	31.1/23.4	7.7	27.1**	thoracic kyphosis, position of C7 plumbline	
									-	p=0.0001	p=0.0001	-	p=0.29	p=0.004	-	p=0.1	p=0.001		
Moustafa (RCT)	2013	Clin Rehab	Lumbosacral radiculopa-thy	E	32 (13f)	43.9 (1.7)	30	2.5 m	11°/19.7°	8.7°	19.1°	6.2/2.3	3.9	2.4	32.4/19.8	12.6	23.1	Improved leg pain, modified Schober	6 m
				C	32 (15f)	43.2 (2.4)	30	2.5 m	11.4°/11.9°	0.5°	11.6°	5.9/3.5	2.4	4.6	31.7/23.7	8.0	31.2	test, H-reflex, inter-vertebral movement	
									-	p<0.001	p<0.001	-	p=0.006	p<0.001	-	p=0.002	p<.0001		
Harrison (nRCT)	2002	APMR	Chronic LBP	E	48 (21)	36.5 (16.6)	36	3 m	−22.4°/−33.7°	11.3°	−34.5°	4.4/0.6	3.8	0.6	n/r	n/r	n/r		15 m
				C	30 (12)	39.4 (13.7)	0	n/a	−36.7°/−35.9°	−0.9°	n/a	4.2/3.7	0.5	n/a	n/r	n/r	n/r		9 m
										n/r			p≤0.01						

Harrison CG: control group with no treatment; Moustafa and Diab x2, CG: comparison groups receiving ‘conventional rehab’ but not LET; LBP: low back pain; f/u: follow-up; f: female; SD: standard deviation; ODI: Oswestry disability index; *3-month f/u; **6-month f/u. Moustafa/Harrison reported L1–L5 posterior tangents; Diab reported L1–L5 Cobb angle.

Table 2. Study quality assessment using the PEDro scale

PEDro scale study quality				Eligibility	Random	Concealed	Baseline	Blinding	Blinding	Blind	Adequate	Intentio-to-	Between group	Point estimates	PEDro
Author	Journal	Year	Condition	criteria	allocation	allocation	comparability	participants	therapists	assessors	f/u	treat analysis	comparisons	and variability	score
Moustafa	Clin Rehab	2013	Sciatica	Y	Y	Y	Y	N	N	N	Y	Y	Y	Y	7/10
Diab	JMPT/ J Back Msk Rehab	2012/ 2013	MLBP	Y	Y	Y	Y	N	N	N	Y	Y	Y	Y	7/10

Table 3. Risk of bias using the SIGN 50 checklist

	SIGN 50 Internal Validity	RCT 1 Sciatica	RCT 2 MLBP	NRCT CLBP
1	Clear study question	++	++	++
2	Randomization	++	++	n/a
3	Adequate concealment	++	++	n/a
4	Blinding of participants/investigator	-	-	n/a
5	Baseline group similarities	++	++	+
6	Intervention only difference	++	++	++
7	Outcome validity/reliability	++	++	++
8	Drop out percentage (<20%)	++	++	+
9	Intention to treat	++	++	++
10	Multi-site similarities	n/a	n/a	n/a
	Overall assessment	++	++	+

The single nRCT was published in 2002[21] and was the first documented use of supine LET in the peer-reviewed literature. Figure 2 depicts supine LET methods. Here, 48 chronic LBP patients with hypolordosis were treated for 36 sessions with supine LET and spinal manipulation over an average 12-week period. Average lumbar lordosis improvement was 11.3° using the Harrison posterior body tangent method (Absolute rotation angle: ARA)[32] from L1–L5 (i.e. L1–L5 ARA). Back pain intensity on a numerical pain rating scale reduced from 4.4/10 to 0.6/10. In 34 of the 48 patients who were available for follow-up, the lordosis and pain levels remained stable at 17.5-months. A control group of 30 chronic LBP patients (matched for gender, age, height, weight, and pain) who received no treatment, demonstrated consistency of pain levels and lordosis values over a 9-month follow-up period.

In 2012, Moustafa and Diab[29] published an RCT consisting of 64, L5–S1 MRI-verified lumbar disc herniation patients randomized equally to a treatment or comparison group that were matched for age, height, weight, gender, smoking, and medication use for back pain. The treatment group received supine LET, and both groups received hot packs and interferential therapy for 30 treatment sessions applied over a 10-week period. At the 10-week post-treatment assessment both groups showed improvement in pain (0–10 pain scale), disability (Oswestry disability index) and functional measures (modified Schober test; neurophysiological test of H-reflex; lumbar spine flexion-extension), with the LET group showing statistically greater improvements. Only the LET group showed an increase in lumbar lordosis. At the 6-month follow-up, the LET group had statistically better values for all outcome measures versus the comparison group, where the comparison group had a regression of pain, disability and functional measures towards baseline pre-treatment levels.

In 2012[30] and 2013[31] Diab and Moustafa reported on another RCT consisting of 80 chronic mechanical LBP patients randomized equally to a LET treatment or comparison group. The study design was similar to the initial RCT in that the treatment group received LET, and both groups received stretching, low back exercises and infrared radiation for 30 treatment sessions applied over a 10-week period. Only the LET treatment group had improvements in lumbar lordosis, as well as many other spinal posture measures including thoracic kyphosis, sacral slope, and positioning of C7 plumb line that were maintained at the 6-month follow-up[31]. At the 10-week assessment, both groups showed reduced pain and disability levels; these improvements were maintained in the treatment group at follow-up, whereas these values regressed towards baseline pre-study values in the comparison group. The same trend was seen for lumbar spine intervertebral translational displacements and rotational movements as assessed on flexion-extension X-rays. Initially, both groups displayed kinematic improvements after 10-weeks of treatment, however the kinematic improvements in the comparison group regressed towards baseline at the 3-month follow-up[30], whereas the LET treatment group maintained their functional improvements.

DISCUSSION

This systematic review of CBP methods of extension traction to increase lumbar lordosis in patients with hypolordosis and lumbar spine disorders details three clinical trials showing positive outcomes in cohorts with chronic LBP and lumbar disc herniation. The RCTs were well designed and scored high on the PEDro scale assessing study quality, and all were low or relatively low for risk of bias as assessed using the SIGN 50 checklist. Both RCTs demonstrated that rehabilitation programs that include lordosis restoration by LET show better long-term (6-month) outcomes versus patients receiving 'cookie-cutter' physiotherapy treatments that included hot packs (15 minutes) and interferential therapy (20 minutes)[29] as well as infrared radiation (15 minutes) and exercises for the quadratus lumborum and hamstring muscles[30, 31].

Of interest, the original nRCT by Harrison et al.[21] demonstrated remarkably consistent findings as compared to the RCT findings[29–31]. Considering the treatment dosage was 20% more in the nRCT[21] as compared to the RCTs[29–31], the LET treatment groups show near identical improvements in lumbar lordosis and pain intensity ratings (Table 1). Similarly, while the nRCTs control group received no treatment and the RCTs comparative groups received similar treatment less the LET, both types of study designs showed no change in lumbar lordosis with correspondingly similar chronic pain intensity at long-term follow-up (6–15 months). This information indicates that a well designed nRCT can produce consistent results relative to high-quality RCT data; this is in direct contrast to a subgroup of critical objectors[33–35] towards these methods in the literature.

From a fundamental standpoint, targeting correction of the physiologic lumbar lordosis is a logical approach to treating patients suffering from LBP and related disorders presenting with lumbar hypolordosis. This approach is also supported by many biomechanical studies[6–14] and recent systematic reviews[15, 16]. The fact that the comparison groups in the RCTs who received non-specific 'cookie-cutter' type treatments, and the fact that the control group in the nRCT getting no treatment, verifies the relative stability of the lumbar lordosis. Traditional treatment modalities do not improve radiographically measured lordosis and therefore, will have limitations to relieving LBP and related disorders in patients presenting with hypolordosis; particularly for long-term outcomes.

The results of the RCTs show a temporal pattern of pain relief and functional improvement after 10 weeks of 'cookie-cutter' (non-lordosis correcting) treatment. In both trials this treatment effect was lost, where these patient's pain and flexibility measures regressed towards baseline, pre-treatment values. The regression of symptoms in the comparative groups likely results from the persistence of the lumbar spine structural hypolordosis deformity, which will exert continuous pathologic and histologic changes in the associated soft tissues[36–38]. The fact that this 'symptom regression trend' was not demonstrated to occur in the groups receiving lordosis improvement with LET is concerning. This trend suggests that while undergoing treatment, patients may inaccurately assume they are receiving appropriate care (due to temporary symptom relief), however, after cessation of treatment, their apparent successful results are likely to regress (loss of initial symptom relief). Also, clinical trials on spine disorders that do not include a follow-up period after the cessation of treatment may be concealing the true limitation (i.e. failures) of their treatment approaches.

Why do traditional low back treatments not restore normal lordosis? One may believe that a common cause of low back pain is from muscle spasms[30], however, muscle spasms do not persist for months and years. Recently, for the cervical spine it was demonstrated that cervical spine alignment alterations (i.e. kyphosis) are not resulting from muscle spasms[39]; in fact, muscle activity mostly increases the lordosis, not straightening it as traditionally assumed. For this reason, traditional treatments (not LET) aimed at the back muscles such as stretching, hot packs and interferential therapy may lessen pain, lessen disability and increase flexibility (albeit temporarily) but not affect the structural spine alignment. As described in the Moustafa[29] and Diab trials[30, 31], this is why these physiotherapy treatments were chosen, to "eliminate the causal role of muscle spasms and/or tightness in changing the magnitude of lumbar lordotic curve"[31].

The discovery of how to non-surgically increase the natural lordosis in the lumbar spine has been through innovative advancements in spinal traction methods. CBP first started treating patients with 'extension traction' for those with lumbar hypolordosis in 1995[40, 41]. It is presumed that hyper-extension of the spine targets the viscoelastic anterior longitudinal ligament and intervertebral discs which with sustained traction stretch (i.e. 10–20 minutes), plastic creep deformation occurs[42, 43] that slowly (requiring repeat treatments) leads to an improvement in spine alignment towards normal. Based on the evidence from several clinical trials, realistic estimates of spine correction can be translated into approximate treatment durations (i.e. 3, 6, 9-months, etc.)[33, 41]. That is, upon radiographically assessing a patient, the spinopelvic parameters of the patient's spinal subluxation deformity will determine the approximate timeline for treatment intervention by these methods.

One of the most important issues to address with any 'new' treatment procedure is to identify the optimum subgroup of patients to likely have the best treatment response. The optimum subgroup for patients to respond to LET has not yet been precisely determined; however, there are logical applications from the literature to predict optimum subgroups. In this regard, the determination of lumbar hypolordosis is complicated by knowledge of a person's specific pelvic morphology (PM) measurements. Beginning in 1992, it was proposed that pelvic morphology influences the normal evolution and magnitude of each person's sacral inclination angle (SIA) and LL[44, 45]. Figure 4 reviews two methods of PM line drawing on lateral lumbo-pelvic radiographs. It is postulated that congruent spine relations exist when the L1–L5 lumbar lordosis magnitude represents at least 80% of the SIA[13, 14, 41]. Similarly, LL magnitudes are considered congruent/normal when they are 10°–20° smaller in absolute value as compared to the PM measurement[41, 46–50]. However, the smaller the PM is using the angle of pelvic incidence (API) measurement (Fig. 4), the more closely the lumbar lordosis should be in absolute value (30° PM approximates a 25°–30° LL). Conversely, the larger the PM value is for a given person, the greater the absolute value of PM−LL will be (difference>20°)[41, 46–50].

Accordingly, an individual's unique correlation between their LL and SIA versus the magnitude of their PM has been demonstrated to determine the presence or absence of LBP, disability, need for intervention, and outcomes[38, 41, 43–51]. For example, Harrison and colleagues[41, 49, 50] compared the correlations between LL vs. SIA and PM values in normal participants vs. a matched sample of chronic LBP patients. They found an altered fit of the lumbar lordosis to both SIA and PM values indicating hypolordosis in the chronic LBP groups (Fig. 5).

For clarity of this PM and LL phenomenon, we present Fig. 6A showing a patient whose LL fits the magnitude of both their SI and PM. While Fig. 6B and Fig. 6C demonstrates 2 patients with an altered fit of their lumbar lordosis to both their SI and PM. We propose it is logical that cases as presented in Fig. 6B and Fig. 6C will respond favorably to LET methods. To date,

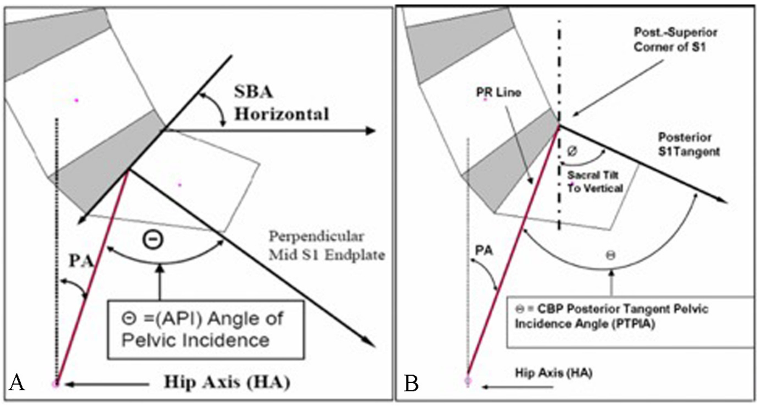

Fig. 4. In A, the angle of pelvic incidence is shown (API) from Duval-Beaupère[44] and adapted by Legaye et al.[45] In B, the CBP Posterior Tangent Pelvic Incidence Angle (PTPIA) is shown as originally developed by Harrison in 2005[49, 50] adapted from the previous methods. First, the PR line is drawn connecting the posterior superior body corner of S1 to the hip axis (bisection of femur head superior apex points). Second a line is drawn along the posterior body margin of S1. The angle ⊖ between the PR line and the S1 Posterior tangent line is the CBP posterior tangent pelvic incidence angle (PTPIA). Copyright© CBP Seminars. All rights reserved. Reprinted with permission.

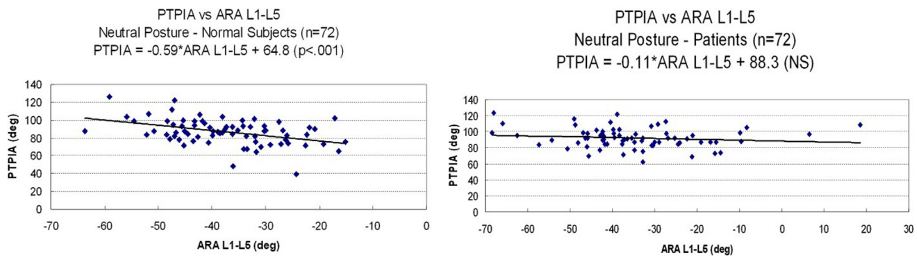

Fig. 5. Regression analysis of posterior tangent pelvic incidence angle (PTPIA) versus lumbar lordosis absolute rotation angle (ARA L1–L5) in 72 normal volunteers (Left) and 72 CLBP patients (Right). Note, the chronic low back pain subjects do not have a statistically significant (NS) correlation or fit of their lumbar lordosis relative to their PTPIA pelvic morphology. This indicates that they have an abnormal fit or an incongruent relationship of their lumbar lordosis to their pelvic morphology[41, 50]. Copyright© CBP Seminars. All rights reserved. Reprinted with permission.

however, no study using LET methods have identified the specific subgroup of LBP populations with lumbar hypolordosis alterations that are the optimum candidates to pursue corrective rehabilitation with LET methodologies.

Due to the limited number of studies, the conclusions from this review are preliminarily. Another limitation is that the measurement method for lumbar lordosis across the studies had slight variation (e.g. L1–L5 ARA[21, 29] vs. L1–L5 Cobb angle[31] vs. T12–S1 ARA[30]); despite this, the significant improvements in LET treatment groups are reported within each trial. Also, the population groups studied were all similar, mid-aged adults (average ages 39–46 years). Although limited, there is good quality evidence that indicates increasing the lumbar lordosis via extension traction as part of multimodal rehabilitation programs are associated with superior outcomes over ‘standard-care’ treatment programs that do not improve hypolordosis[52]. The strength of the RCT designs was accomplished by having randomized comparison groups who received identical treatments less the traction. The regression of initial symptom relief towards baseline following care in the non-traction comparison groups substantiates both that the increase in lordosis was achieved by the extension traction, and that the improvement in physiologic lumbar lordosis led to the better and stable outcomes following care.

Several future studies are needed to overcome the weaknesses identified and improve our understanding of LET methods discussed in this review. For example, a study seeking to identify the optimum subgroup of patient lumbar curvatures that will respond to LET as they relate to initial pelvic morphology values is needed. Second, a study investigating multiple programs of LET applications is needed; in this way the optimum dose response over time can be identified for those patients who improve but still remain with pain, disability, and loss of curvature. Third, an RCT with a cross-over design is needed in order to more accurately identify that patients receiving LET applications for lumbar hypolordosis are the ones who indeed have the optimum improvement for their back pain and related disabilities.

In brief, a limited amount of good quality evidence substantiates the use of supine LET methods as part of a rehabilitation

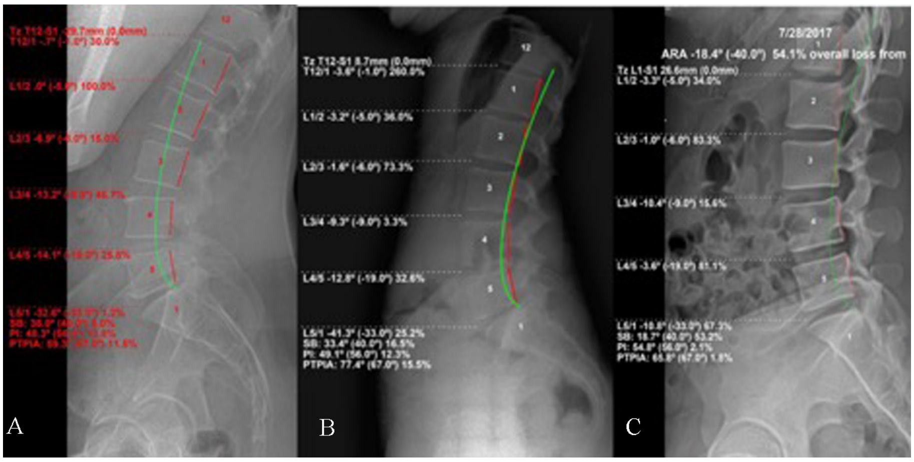

Fig. 6. Different 'fits' or relationships of the lumbar lordosis absolute rotation angle (ARA L1–L5) relative to both the pelvic morphology (PI) and sacral base (SB) angles can explain normal distributions as well as abnormal relationships of the lumbar lordosis in normal vs. chronic low back pain populations. In A, the normal relationship of pelvic morphology (PI: 48.3° and PTPIA: 59.3°) relative to a normal sacral base (SB: 38°) angle and a normal lumbar lordosis (ARA: −34.2°, minus value indicates extension); this would be considered a normal fit or response of lordosis to PM and SB. In B, an abnormal relationship of a slight decreased sacral base (SB: 33.4°) angle and a hypo-lordosis (ARA: −26.8°) relative to pelvic morphology (PI: 49.1° and PTPIA: 77.4°). In C, an abnormal relationship of a moderate decreased sacral base (SB: 18.7°) angle and a hypo-lordosis (ARA: −18.4°) relative to pelvic morphology (PI: 54.8° and PTPIA: 65.8°). It is anticipated that patients with an abnormal decreased lordosis relative to either a normal PM and/or a normal SB angle as in B and C above, will be the ones who are optimum responders to LET methods.

program to increase the hypolordotic lumbar spine in low back pain populations with and without lumbar disc herniation. Preliminarily, these studies indicate that LET provides longer-term relief to patients with low back disorders versus the conventional rehabilitation approaches tested. The presented evidence points to the fact that 'conventional' low back treatments do not structurally improve the lordosis and therefore, may leave patients in predisposition for future LBP after treatment cessation. It is essential for future research to include post-treatment follow-up in low back pain trials to fully assess treatment effect; importantly, including the possible regression of initial symptom relief after cessation of care. Future investigations testing LET methods are needed for a more adequate understanding of this now important treatment procedure, including but not limited to older and younger patient populations.

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 described in this manuscript. Authors Dr. Niousha Navid Ehsani and Professor Ibrahim Moustafa have nothing to declare.

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