Review of Sagittal Disorders, Sensori-Motor Control and Altered Athletic Skills

Deed E. Harrison, DC
President Chiropractic BioPhysics® (CBP®) Technique
President CBP® NonProfit, Inc.

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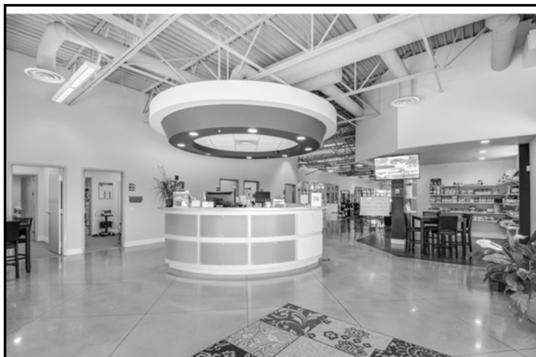

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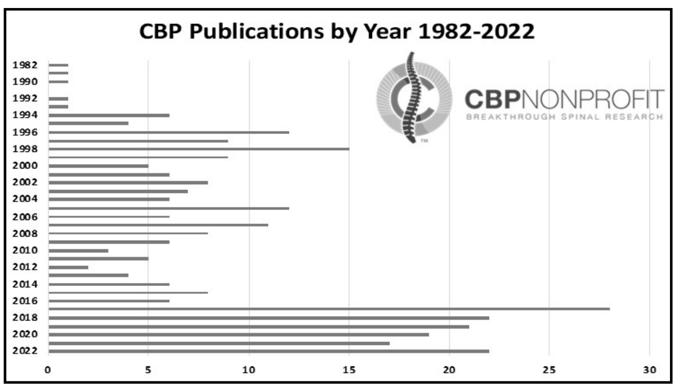
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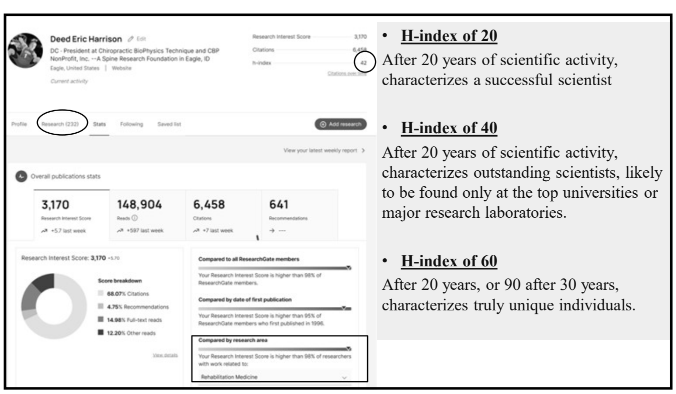
Deed Eric Harrison
3,170
148,904
6,458
641
• H-index of 20
After 20 years of scientific activity, characterizes a successful scientist
• H-index of 40
After 20 years of scientific activity, characterizes outstanding scientists, likely to be found only at the top universities or major research laboratories.
• H-index of 60
After 20 years, or 90 after 30 years, characterizes truly unique individuals.

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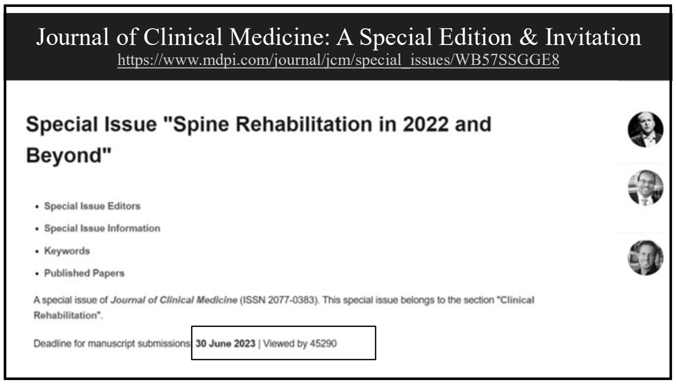
Journal of Clinical Medicine: A Special Edition & Invitation
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Special Issue "Spine Rehabilitation in 2022 and Beyond"
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Keywords
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A special issue of Journal of Clinical Medicine (ISSN 2077-0383). This special issue belongs to the section "Clinical Rehabilitation".
Deadline for manuscript submissions: 30 June 2023 | Viewed by 45290

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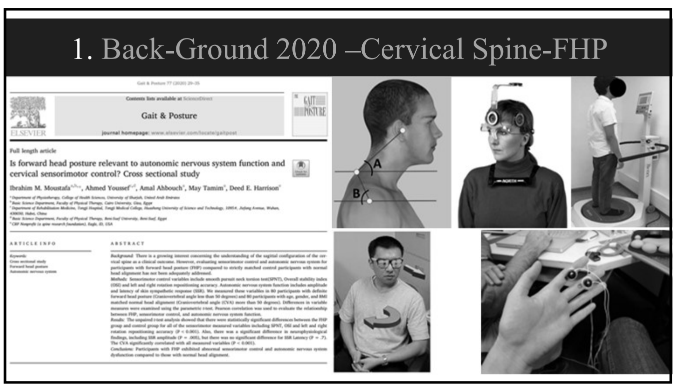
1. Back-Ground 2020 –Cervical Spine-FHP
Gait & Posture
Is forward head posture relevant to autonomic nervous system function and cervical sensorimotor control? Cross sectional study
A
B

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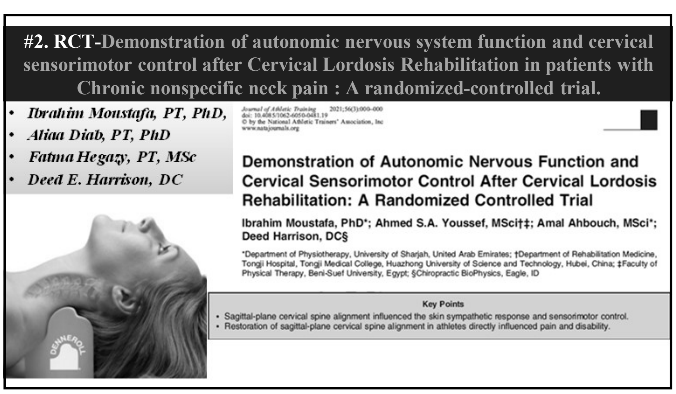
#2. RCT-Demonstration of autonomic nervous system function and cervical sensorimotor control after Cervical Lordosis Rehabilitation in patients with Chronic nonspecific neck pain : A randomized-controlled trial.
Ibrahim Moustafa, PT, PhD,
Aliaa Diab, PT, PhD
Fatma Hegazy, PT, MSc
Deed E. Harrison, DC
Journal of Athletic Training 2021;56(3):000-000
doi: 10.4085/1062-6050-0481.19
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Demonstration of Autonomic Nervous Function and Cervical Sensorimotor Control After Cervical Lordosis Rehabilitation: A Randomized Controlled Trial
Ibrahim Moustafa, PhD*; Ahmed S.A. Youssef, MSci†‡; Amal Ahbouch, MSci*; Deed Harrison, DC§
*Department of Physiotherapy, University of Sharjah, United Arab Emirates; †Department of Rehabilitation Medicine, Tongji Hospital, Tongji Medical College, Huazhong University of Science and Technology, Hubei, China; ‡Faculty of Physical Therapy, Beni-Suef University, Egypt; §Chiropractic BioPhysics, Eagle, ID
Key Points
Sagittal-plane cervical spine alignment influenced the skin sympathetic response and sensorimotor control.
Restoration of sagittal-plane cervical spine alignment in athletes directly influenced pain and disability.

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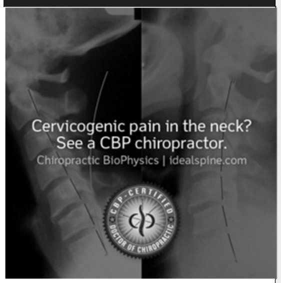
Introduction



- Neck pain is the 4th leading cause of disability world wide: 30-50% in workers.
- < 1/3 become chronic.
- Sensori-motor control is altered in CNSNP and this becomes a viscous cycle.
- Autonomic disturbances result from joint afferent articular disturbances, but cause / effect remains under-studied and unknown.
- Abnormal posture and altered cervical lordotic curves have been found to play a role in chronic CNSNP sufferers.

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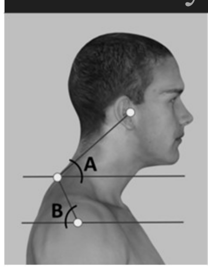
Study Hypothesis



- There is a lack of controlled studies assessing the effect of the cervical spine sagittal alignment on sensorimotor and autonomic nervous functions.

THEREFORE OUR STUDY SEEKS:

- Does correction of cervical sagittal alignment lead to improved sensorimotor control measures?
- Does sagittal cervical correction lead to improvements in the autonomic nervous system's function?

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Design & Setting

Design: Pan African Clinical Registry. (PACTR201806003435331)

- Prospective, parallel-group, randomized controlled study with 10-weeks of treatment and a 1-year follow-up.

Setting:

- University research out patient PT Dept, Cairo, University.

Participants Randomized to Study or Control:

- 110- (44 F & 76M) patients 33.1 ± 8 years Old—
  - Randomized for equal numbers to PT Control and Experimental group receiving PT & Denneroll.

Sample size & Stats: Calculated based on proper projects methodology & Intent to Treat Designs

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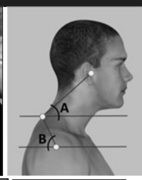
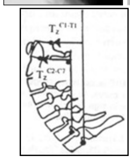
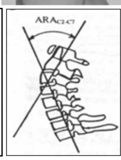
Inclusion Criteria

Neck Pain:
- 18 yrs of age or >
- Chronic, Non-specific
- Decreased ROM

Radiographic Assessments:
- Hypolordosis ARA ≤ 20°
- Forward head posture:

AHT ≥ 25 mm

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Exclusion Criteria- Exam by Neurologist

- History of stroke,
- Diagnosis of a bleeding disorder,
- Neuro-disorder and Upper MND
- Currently undergoing anticoagulation treatment,
- Presence of inflammatory joint disease,
- Headache
- Pregnancy,
- Patient's whose pain is Not-relieved by NSAID's.
- Evidence of narcotic or abuse.
- Nocturnal pain
- Acute musculo-skeletal injury

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Participant Flow Chart

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Patient Demographics

	Experimental group (n=55)	Control group (n=55)
Age(y)	40.5±3	41±4
Weight(kg)	76 ± 10	80 ± 9
Gender (%)		
Male	30	29
Female	25	26
Body mass index mean (SD),Kg/m^2		
Marital status		
Single	4	3
Married	49	51
Separated, divorced, or widowed	2	1
Pain duration		
1-5 y	22(36.5%)	19(31.5%)
>5 y	38(63.5%)	41(68.5%)
Smoking		
Light smoker	33	30
Heavy smoker	5	7
No Smoker	12	13

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Methods--Treatment

- Both groups 10-wk x 3 multi-modal program:
  - ✓ Soft Tissue Mobilization-cervical-upper thoracic
  - ✓ Cervical & Thoracic Spine Mobilization / manipulation. Thrust to upper middle and lower region.
  - ✓ Hot packs for 15 min & TENS for 20 minutes.
  - ✓ Home Functional Exercise Protocol---Deep cervical flexor endurance training, Cervical extension/retraction, scapular retraction exercises (supine), 10 seconds and 10 reps.
  - ✓ At Home: 1x daily with log sheets and weekly checks.
- Study group received Denneroll cervical traction 3 x wk for 10 weeks.

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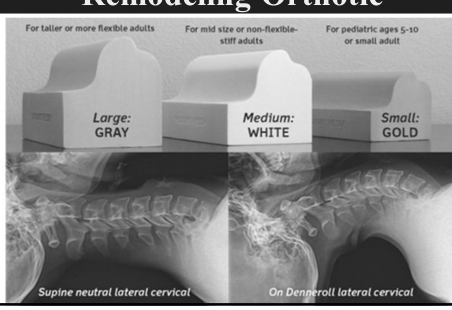
Denneroll Home Cervical Remodeling Orthotic



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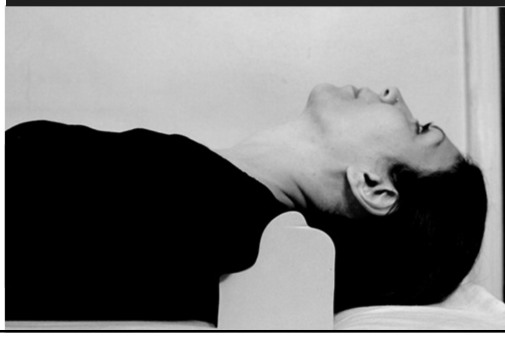
Denneroll Placement



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Methods: Outcome Measures

X-ray Outcome measures-:

- C2-C7 horizontal offset for anterior head translation.
- ARA C2-C7= Cervical Lordosis.

Pain and Functional Measures

- **NRS 0-10**:
- **NDI**: Minimal clinically important change (MCIC)= 10.5 points
- **Sympathetic Skin Response**: EMG electrodes palmer-reference dorsum of hand –stimulus contralateral side at wrist-- Bilateral.
- **Cervical Positioning sense:** CROM –head repositioning to 30°
- **Head Eye Movement Control:** Smooth pursuit neck torsion test.
- **Posture Stability**: Platform –Biodex Balance System. 4/8 resistance to perturbations.

Evaluation intervals: baseline, 10 weeks, 1 year follow up

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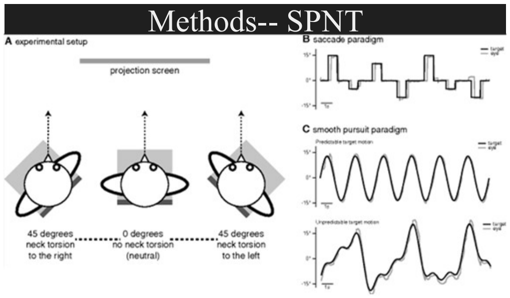
Methods-- SPNT



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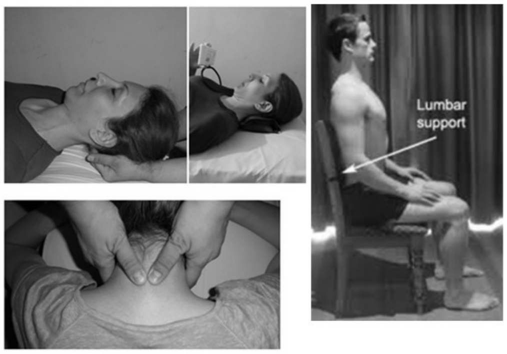

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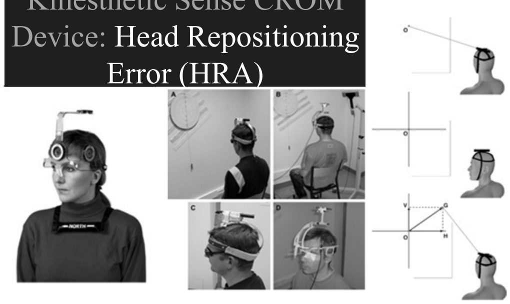
Kinesthetic Sense CROM Device: Head Repositioning Error (HRA)



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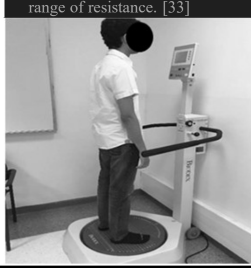
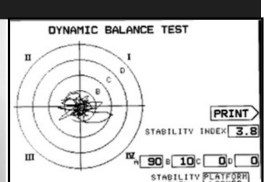
- Three 10-second trials, with 20 second rest period between trials. Analysis was based on the measurements average of the three trials. Both dynamic and static balance testing were measured using the same protocol with the BBS set to a dynamic position of 4 out of 8. This position represents the middle level of the platforms available range of resistance. [33]





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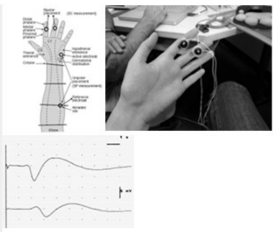
Sympathetic Skin Resistance Response

- Sympathetic Skin Response (SSR) measures change of the electrical potential of the skin.
- The recorded skin potential comes from the activated eccrine sweat gland.
- The amplitude and configuration are adjusted by sweat gland epithelium and the overlying epidermis.



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Results: Sagittal Alignment

		Pre treatment	Post treatment	1-year follow up	P G	P T	P G Vs t
ARA	E	5.3±5	20±2.9	19.4± 2.1	<0.001*	<0.001*	<0.001*
	C	5.8±4.9	6.9±4.7	5.7 ±.4.9			
.4 [-2.6 1.1]			<0.001 [11.5 14.5]	<0.001* [12.2 15.08]			
AHT	E	3.6±.6	1.1±.5	1.3±.6	<0.001*	<0.001*	<0.001*
	C	3±0.5	2.9±0.7	2.9±.8			
.5 [-.17 .3]			<0.001* [-2 -1.58]	<0.001* [-1.93 -1.48]			

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Patient Perceptive Outcomes

		Pre	Post	1-year	effect-size r 10 week vs. Baseline	effect-size r 1-year vs. Baseline	P G	P T	P G Vs t
NDI	E	33.7±3.2	20.6±1.9	10.9±4.2	.9	.9	<0.001	<0.001 *	<0.001 *
	C	32.2±3.5	21±1.6	26.1±3.6	.8	.6			
.017* [.28 2.8]			.1 [-1.15 -.2]	<0.001* [-16.6 -13.8]					
Pain intensity	E	5.5±1.2	1.9±.7	1.3±.5	.8	.9	<0.001	<0.001	<0.001
	C	5.3 ±.9	2.1±.6	4.2±.7	.9	.5			
0.24 [-.158 .63]			.07 [-.458 .18]	<0.001* [-4.087 -3.63] [-4.043-3.58]					

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Sensori-Motor Outcomes

Elector-oculog raphy
OSI balance
HRA

		Pre treatment	Post treatment	1-year follow up	P: G	T	G Vs t
SPENT	E	.3±.07	.2±.07	.1±.07	<0.001*	<0.001*	<0.001*
	C	.36 ±.04	.2±.06	.3±.05			
		.5 [-.031 .016]	.48 [-.036 .017]	<0.001* [-.228 -.175]			
OSI	E	.7±.07	.4±.1	.49± .06	<0.001*	<0.001*	<0.001*
	C	.6±.1	.5±.14	.6 ±.07			
		.007 [.054 .123]	.12 [-.086 .011]	<0.001* [-.16 -.109]			
Repositioning accuracy Right rotation	E	3.4±.7	2.6±.6	1.8±.8	<0.001*	<0.001*	<0.001*
	C	3.2±.9	2.4±.7	3.4±1.1			
		.06 [.025 .66]	.3 [-.15 .38]	<0.001* [-1.9 -1.24]			
Repositioning accuracy left rotation	E	3.7±1.1	2.5±.8	1.5±.5	<0.001*	<0.001*	<0.001*
	C	3.8 ±.9	2.8±.5	3.7±.7			
		0.3 [-.58 .21]	.07 [-.531 .021]	<0.001* [-2.33 -1.7]			

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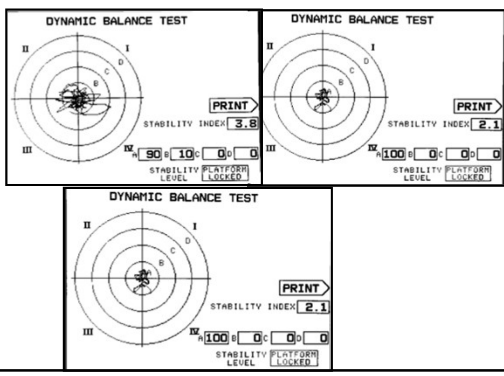

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Change in Neuro-Physiology

		Pre	10-week Post	1-year	effect-size r 10 week vs. Baseline	effect-size r 1-year vs. Baseline	P: G	T	G Vs t
SSR amplitude	E	1.89±.2	1.4±.3	1.2± .2	.7	.9	<0.001*	<0.001*	<0.001*
	C	1.8±.3	1.6±.2	1.7 ±.6	.3	.1			
		.4 [-.061 .148]	.005 [-.284 -.051]	<0.001* [-.735 -.521]					
SSR latency	E	1.18±.1	1.3±.1	1.4±.1	-0.5	-0.7	<0.001*	<0.001*	<0.001* *
	C	1.2±0.1	1.3±0.9	1.1±.1	-0.07	.4			
		.4 [-.058 .024]	.7 [-.033 .044]	<0.001* [.133 .2]					

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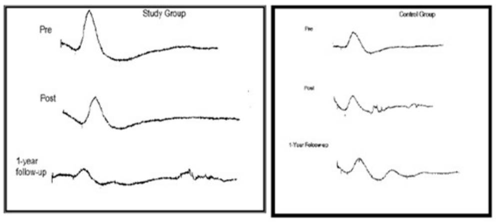
Skin Sympathetic Reflex



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#4. Is thoracic kyphosis relevant to pain, autonomic nervous system function, disability, and cervical sensorimotor control in patients with Chronic nonspecific neck pain? A Cross Sectional Study.

Ibrahim M. Moustafa PT, PhD; Tamer Shousha PT, PhD; Ashokan Arumugam, PT, PhD; Deed E. Harrison DC

COI Disclosure:

DEH provides continuing education lectures and is the CEO of a company that distributes products to physicians in the U.S.A. used for the rehabilitation of postural abnormalities.
All other authors declare that they have no competing interests.

SOSORT

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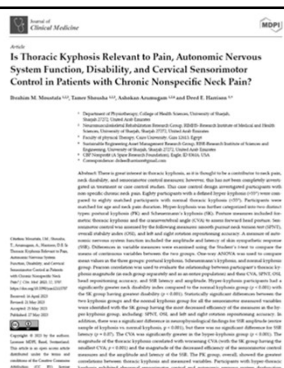
Journal of Clinical Medicine

MDPI

Article

Is Thoracic Kyphosis Relevant to Pain, Autonomic Nervous System Function, Disability, and Cervical Sensorimotor Control in Patients with Chronic Nonspecific Neck Pain?

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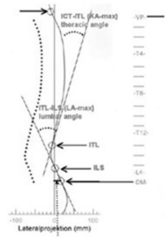
Study Purpose and Hypothesis

- The purpose of this study was to investigate any differences in sensorimotor control, disability, and autonomic dysfunction in chronic nonspecific neck patients with a thoracic hyper-kyphosis compared to matched control participants with a normal kyphosis.
- We hypothesized that those with thoracic hyper-kyphosis would have impaired sensorimotor control and autonomic dysfunction compared to those with a normal kyphotic thoracic alignment.



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Design and Setting

<u>**Setting**</u>: Farouk Hospital, Cairo University Research Dept, Egypt.

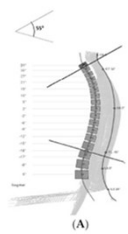
- Informed Consent & Ethical approval #: CA-REC-22-5-20,

<u>**Participants Case-Control:**</u>

- Study-80 participants with definite thoracic hyper kyphosis-
  - 35 Postural Kyphosis; 45 Type 1 Scheuermann's Kyphosis.---*<u>Radiography confirmed.</u>*
- Control-80 participants with normal Kyphosis matched for:
  - Age-, Sex-, BMI-, Marital status-, Smoking, Education, <u>**Pain Intensity & Duration.**</u>

<u>**Sample size & Stats:**</u>

- Pilot project to identify an effect size of 0.6, indicated 70 per each group was needed. Increased to 80 for a statistical power of 80%.



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Study Inclusion / Exclusion Criteria

Thoracic Normal: Angle $< 55°$

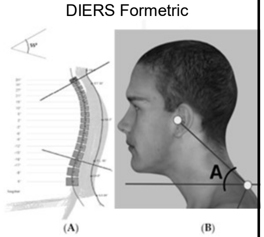
Thoracic Hyper-kyphosis: Angle $\geq 55°$

1. Chronic non-specific neck pain with no radiculopathy.
2. Participants were given the NRS.
3. Participants were given the NDI.

<u>**Exclusion criteria:**</u>

1. Signs or symptoms of "red flags".
2. History of previous spine surgery, radiculopathy, etc.
3. History of cervical trauma: MVC.

DIERS Formetric



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METHODS: Kinesthetic Sense CROM Device
Head Repositioning Error (HRA)

- 30° rotation to the left and right.
- Repeat on their own 3 x each side.
- How close in Degrees and % Error.
- 10% is benchmark.

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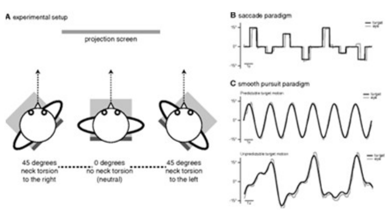
METHODS: Smooth Pursuit Neck Torsion Test (SPNT)
Electro-oculography

Difference between the average gain in the neutral and torsion positions for left vs. right rotation.
Reported as a percentage (%) of error of corrective saccades (eye movements)
10-20% error is normal and greater than 20% error is abnormal.



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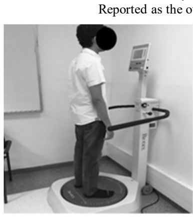
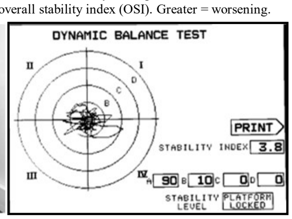
METHODS: Balance-Biodex platform.

Three 10-second trials, with 20 second rest period between trials.
The balance system was set to a dynamic position of 4 out of 8.
Reported as the overall stability index (OSI). Greater = worsening.





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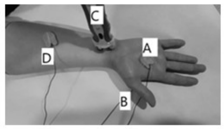
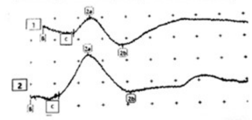
METHODS: Sympathetic Skin Resistance Response (SSRR)

A) Active surface electrodes were attached on the palmar side,
B) References were placed on the dorsum of the hand.
C) Ground.
D) Stimulating Electrode.



Followed Previously Published Validated Protocol:
- 20 minutes in a room with a temperature of 22–24°C.
- Measurements were taken from both left and right sides.
- An intensity of 20–30 mA with an irregular interval of more than one minute was applied to prevent habituation.
- Skin potentials were recorded for a 10 s analysis period.
- Mean values of three trials were used for each parameter.
- Sweep speed was 500 ms / div.
- Latency and Amplitude.



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RESULTS: Table 1.- Baseline participant demographics.

Variables	Postural Kyphotic (n = 80)	Normal (n = 80)	P value
Age (years)	25.1 ± 3	24 ± 4.6	0.07
Weight (kg)	66 ± 10	60 ± 9	0.9
Sex			
Male	38	32	0.2
Female	42	48	
Marital status			
Single	61	59	0.3
Married	19	21	
Separated, divorced, or widowed	0	0	
Pain duration (months)	18 ± 4	17 ± 5	0.16
Smoking			
Light smoker	29	32	0.4
Heavy smoker	14	15	
No Smoker	37	33	

- Chi-squared test for categorical and Student's t-test for continuous variables.
- No Difference between any of the 3-groups.

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Table 2.- Between group comparisons of pain and disability

Variables.	Entire Kyphotic group (n=80)	Normal group (n=80)	Cohen's d effect size	P value (95% CI)
NDI	37.3 ± 4.1	29.8 ± 2.4	2.2	< .001* [-8.[illegible]]
Pain intensity	5.3 ± 2.0	4.9 ± 1.8	0.20	0.18 [-0.99 , 0.19]
Postural Kyphosis vs. Scheuermann's	**Postural Kyphosis N = 35**	**Scheuermann's Kyphosis N = 45**	**Cohen's d effect size**	**P value (95% CI)**
NDI	35.2 ± 2.4	39.1 ± 4.5	1.04	< .001* [-5.[illegible] 2.36]
Pain intensity	4.6 ± 1.4	5.9 ± 2.3	0.66	0.18 [-2.12 , - 0.48]

CI= confidence interval; NDI= neck disability index; Pain intensity is 0-10 where 0 is no pain and 10 is incapacitated; all values are expressed as means ± standard deviation. * = statistically significant.

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Figure. Box Plot of Thoracic Kyphosis Between Groups.

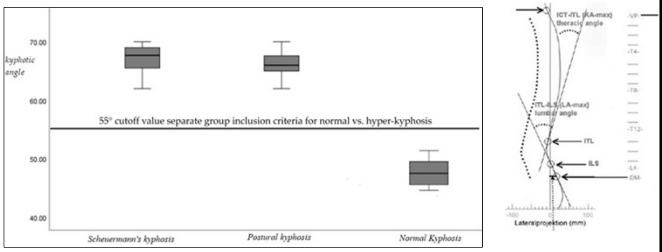

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Figure 5. CVA in THK vs. Control Groups

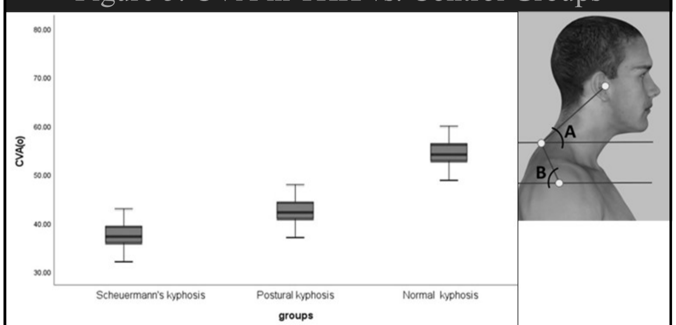

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Table 3.- Between group comparisons of sensorimotor control, CVA, and SSR.
Hyper-Kyphotic group as a whole statistically worse for all measured variables except SSR Latency.

Variables	Kyphotic group	Normal Group	Cohen's d effect size	P value [95% CI]
CVA (°)	41 ± 5	53 ± 4	2.65	< .001* [10.6 , 13.4]
Smooth pursuit neck torsion test (% error)	0.41 ± 0.17	0.31 ± 0.14	0.6	< .001* [-0.15 , -0.05]
**Overall stability index (refer to methods)	0.62 ± 0.2	0.42 ± 0.1	1.26	< .001* [-0.05 , -0.14]
Head repositioning accuracy (°) Right	4.0 ± 1.5	3.0 ± 1.2	0.74	< .001* [-0.57 , -1.42]
Head repositioning accuracy (°) Left	4.3 ± 1.8	3.3 ± 1.5	0.6	< .001* [-0.45 , -1.58]
Sympathetic skin resistance Amplitude	2.9 ± .9	2.1 ± .7	.87	< .001* [-0.54 , -1.05]
Sympathetic skin resistance Latency	1.2 ± .4	1.3 ± .3	0.2	0.07 [-0.01 , 0.21]

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Table 4.- Postural vs. Scheuermann's Kyphosis comparisons.

Scheuermann's kyphosis group statistically worse for all measured variable except SSR Latency.

Variables	Postural Kyphosis N=35	Scheuermann's Kyphosis N=45	Cohen's d effect size	P value [95% CI]
CVA (°)	44 ± 4	38.5 ± 4.5	1.28	< .001*
Smooth pursuit neck torsion test (% error)	0.34 ± .13	0.48 ± .18	0.87	< .001*
**Overall stability index (refer to methods)	0.56 ± .2	0.68 ± .3	0.46	< .001*
Head repositioning accuracy (°) Right	3 ± .7	4.8 ± 1.6	1.4	< .001*
Head repositioning accuracy (°) Left	3.8 ± 2	4.7 ± 1.6	0.5	0.04*
Sympathetic skin resistance Amplitude	2.4 ± .6	3.3 ± 1	1.06	< .001*
Sympathetic skin resistance Latency	1.3 ± .3	1.2 ± .5	0.24	.29

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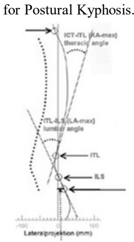
Table 5.- Pearson r correlations for Kyphotic angle and variables.

Moderate to strong correlations between variables with significantly greater correlations for Postural Kyphosis.

Correlation between variables	Postural Kyphosis r (p value) N = 35	Scheuermann's Kyphosis r (p value) N = 45	Normal group r (p value) N = 80	Entire sample r (p value) N = 160
CVA	-0.7 (< 0.001)	-0.6 (< 0.001)	-0.51 (< 0.001)	-0.61 (< 0.001)
NDI	0.58 (< 0.001)	0.50 (< 0.001)	0.51 (< 0.001)	0.67 (< 0.001)
Pain intensity (NRS)	0.5 (< 0.001)	0.35 (0.03)	0.34 (0.043)	0.53 (< 0.001)
Smooth pursuit neck torsion test	0.54 (< 0.001)	0.50 (< 0.001)	0.50 (< 0.001)	0.58 (< 0.001)
Overall stability index	0.61 (< 0.001)	0.49 (< 0.001)	0.52 (< 0.001)	0.59 (< 0.001)
Head repositioning accuracy (Right)	0.7 (< 0.001)	0.54 (< 0.001)	0.61 (< 0.001)	0.74 (< 0.001)
Head repositioning accuracy (Left)	0.67 (< 0.001)	0.52 (< 0.001)	0.61 (< 0.001)	0.71 (< 0.001)
Sympathetic skin resistance amplitude	0.7 (< 0.001)	0.56 (< 0.001)	0.61 (< 0.001)	0.69 (< 0.001)
Sympathetic skin resistance latency	-0.2 (0.05)	-0.5 (< 0.001)	-0.36 (< 0.001)	-0.49 (< 0.001)

CVA- Craniovertebral angle; NDI = neck disability index; NRS = numerical rating scale.



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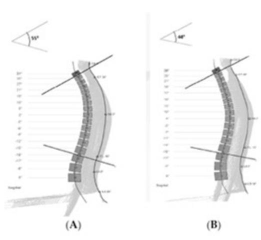
CONCLUSIONS

- Thoracic Hyper-Kyphosis posture negatively affects sensorimotor control.
- Thoracic Hyper-Kyphosis negatively affects the autonomic nervous system.
- There is Moderate correlation between Thoracic Hyper-Kyphosis and the measured sensorimotor outcomes.
- There is Moderate to Strong correlation between Thoracic Hyper-Kyphosis and SSRR amplitude.



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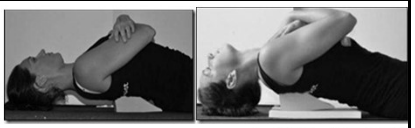
#5: RCT

Journal of Clinical Medicine — MDPI

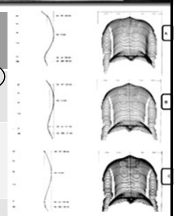
Article

Reduction of Thoracic Hyper-Kyphosis Improves Short and Long Term Outcomes in Patients with Chronic Nonspecific Neck Pain: A Randomized Controlled Trial

Ibrahim Moustafa Moustafa, Tamer Mohamed Shousha, Lori M. Walton, Veena Raigangar and Deed E. Harrison



		Pre treatment	Post treatment	1-year follow up
Kyphotic angle ICT-ITL max: measured between tangents of cervicothoracic junction (ICT) and of thoracolumbar junction (ITL)	E	82.15±5.3	63.40±6.2	64.6 ±5.7
	C	83.15 ±4.9	82.2±4.5	83.8±3..8
		.5 [-4.3 2.3]	<0.001* [-22.9 -15.8]	<0.001* [-22.3 -16.1]



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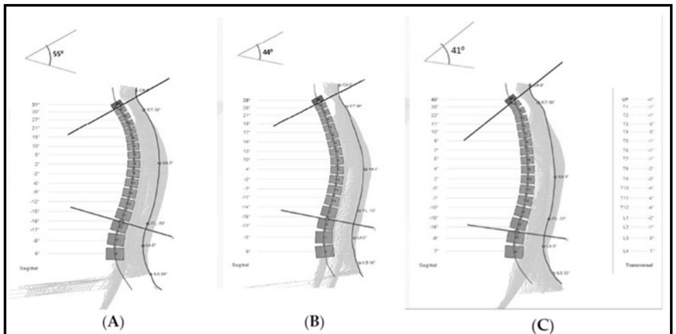

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#6

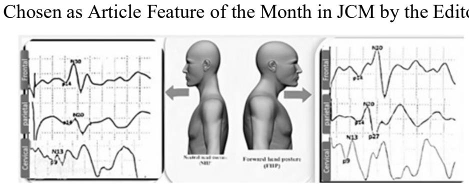
Journal of Clinical Medicine — MDPI

Article

Does Forward Head Posture Influence Somatosensory Evoked Potentials and Somatosensory Processing in Asymptomatic Young Adults?

Ibrahim M. Moustafa [1,2], Aliaa Attiah Mohamed Diab [1,3] and Deed E. Harrison [4,*]

- Chosen as Article Feature of the Month in JCM by the Editorial Board—2nd time!



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Design & Setting

Design: Pan African Clinical Registry.

Setting: University research PT Dept, Cairo, University.

- **Ethical approval number:** REC-105 21-03-11-03-S

Participants Case-Control: Study or Control:

- Study-60 subjects with definite forward head
- Control 60 normal posture: age-, sex-, and body mass index (BMI)-matched

Sample size & Stats:

- Mean differences and standard deviation of the N30 potential were estimated to be 0.5 and 0.6, respectively, from this study. Accordingly, at least 60 subjects per each group,
- Significance level of 5% and a statistical power of 80%, were needed in the current study.

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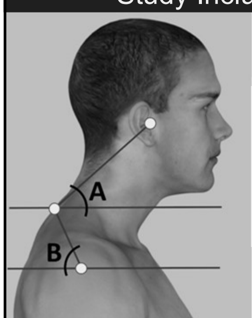
Study Inclusion & Exclusion Criteria



Forward Head Posture: A ≤ 50°

Controls: A ≥ 55°

I. Systemic pathology, including any inflammatory joint disease.
II. Prior history of apparent injury or surgery relating to the musculoskeletal system, or
III. Disorder connected to the spine and extremities.
IV. Musculoskeletal pain in the last 3- months.

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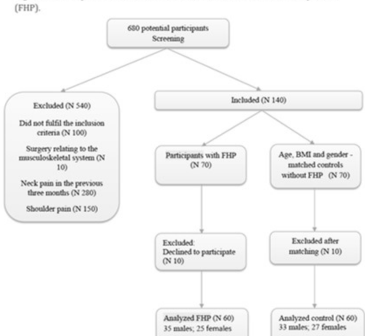
Figure 1. Participants' inclusion and exclusion flow chart. Forward head posture (FHP).



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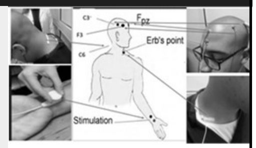
Neuro-Physiological Assessment

Electromyogram device (Neuropack S1 MEB-9400K, Nihon Koden, Japan)

- **N13** potential, at Cv6 (dorsal horn)
- **P14** potential, recorded over parietal and frontal electrodes-- nucleus cuneatus;
- **N20 and P27** potentials, contralateral parietal – primary somatosensory cortex;
- **N30** potential: thalamus, premotor area, basal ganglia and primary motor cortex.
- **N13-N20** Central Conduction aka- spinal cord velocity.



Band pass was set to 5–1500 Hz (−3 dB at the cutoff point, 6 dB per octave), analysis time of 100 msec and a ban width of 103 μsec. Stimuli were electrical square pulses of 0.2 msec duration A total of 800 sweeps were averaged. Each test was repeated at least twice.

- Stimulus 3 times above the sensory level.
- Recording electrodes (impedance below 5 kΩ) were placed over C6 spinous (Cv6),
- Parietal and frontal regions contralateral to stimulation (P3, P4, and F3, F4);
- Reference electrode at earlobe ipsilateral.

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Participant Demographics

Variable	FHP (n = 60)	CG (n = 60)	P-value
Age (years)	23.5 ± 2	25.9 ± 2	.07
Weight (kg)	67.2 ± 3	69.2 ± 5	.11
Gender (%)			
Male	35 (58%)	33 (55%)	.3
Female	25 (42%)	27 (45%)	
Smoking			
Light smoker	18	16	.2
Heavy smoker	0	0	
No Smoker	42	44	
Educational level			
Bachelor or Master	43	36	< .005
High school or less	17	24	
Marital status			
Married	32	24	< .005
Not married	28	36	
BMI			
Normal	45	26	< .005
Obese	15	34	
Working hours			
Full time	22	42	< .005
Part time	38	18	

- ✓ A generalized linear model was used to compare the neurophysiological scores between groups, with adjustment for potential confounding variables (educational level, marital status, BMI, and number of working hours per week).
- ✓ Multiple logistic regression models were used to assess the predictors of the neurophysiological outcomes: (P14, 231 N20, P27, N30, N13, and N13-N20).

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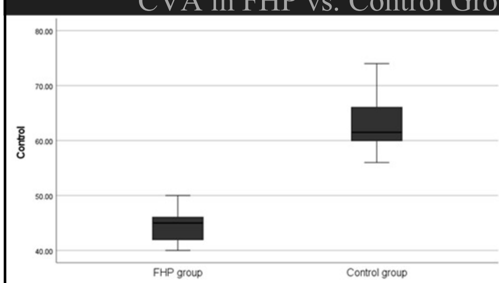
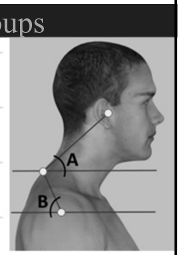
CVA in FHP vs. Control Groups





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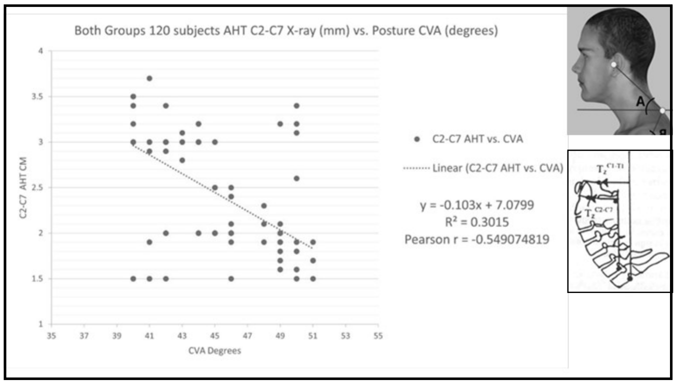

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RESULTS: Group Differences. (A) = GLM

Neurophysio-logical Outcome Measure	FHP group	Control group	Mean Difference between the two groups	(95% CI) / Cohen's d	P value	P Value (A)
N9	1.8 ± 0.2	1.7 ± 0.34	0.1	[0.07 , 0.21] / 0.1	= .07	0.6
P14	1.67 ± 0.6	1.3 ± 0.63	0.37	[0.25 , 0.49] / 0.77	< .005	.02
N20	2.61 ± 0.61	2.1 ± 0.52	0.51	[0.33 , 0.6] / 0.9	< .005	< .005
P27	3.2 ± 0.7	2.7 ± 0.5	0.5	[0.41 , 0.69] / 0.8	< .005	.04
N30	2.91 ± 0.64	2.4 ± 0.58	0.51	[0.359 , 0.69] / 2.45	< .005	.003
N13	2 ± 0.5	1.6 ± 0.45	0.4	[0.11 , 0.35] / 0.8	< .005	.004
N13-N20	1.77 ± 0.46	1.5 ± 0.51	0.27	[0.07 , 0.51] / 0.56	= .004	< .005

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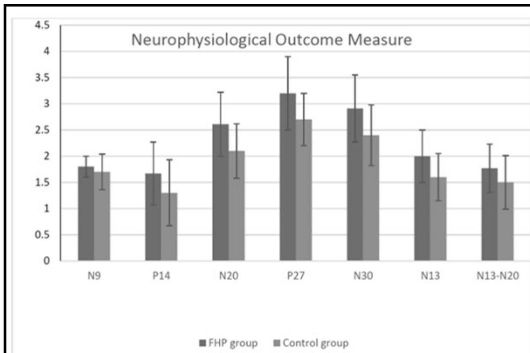

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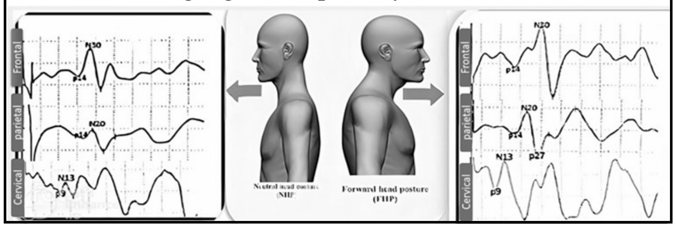
<u>The frontal N30 (P22–N30 complex):</u> The N30 potential reflects the functional connectivity of sensorimotor integration, which includes the thalamus, premotor area, basal ganglia and primary motor cortex.



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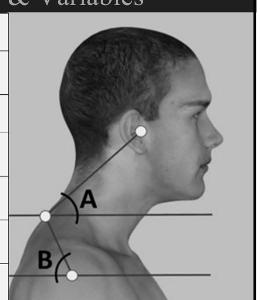
Correlations Between FHP & Variables

Correlation	CVA FHP r (P value)	CVA CG r (P value)
N9 (Peripheral)	-.44 <0.001	-.5 <0.001
N13 (Spinal)	-.67 <0.001	-.54 <0.001
P14 (Brainstem)	-.58 <0.001	-.57 <0.001
N20 (Parietal)	-.49 <0.001	-.51 <0.001
P27 (Parietal)	-.58 <0.001	-.6 <0.001
N30 (Frontal) Sensori-Motor Integration	-.64 <0.001	-.61 <0.001
N13-N20 Central Conduction Time	-.61 <0.001	-.56 <0.001



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- **<u>Full time work</u>** increased the odds of having a higher amplitude of the neurophysiological potentials and slower N13-N20 conduction time; $p < 0.005$.
- **<u>Each 1 degree increase in the CVA</u>** decreased the amplitudes of the potentials and resulted in a faster more efficient N13-N20 conduction time; $p < 0.005$.

Predictors	P14 Odds ratios (p value)	N20 Odds ratios (p value)	P27 Odds ratios (p value)	N30 Odds ratios (p value)	N13 Odds ratios (p value)	N13-N20 Odds ratios (p value)
BMI [Obesity]	.4 .06	.23 .06	.13 .3	.16 .34	.2 .06	.2 .06
Educational level [Bachelor or Master]	1.2 .4	3.2 .08	2.3 .3	1.2 .4	2.4 .32	1.5 .42
Marital status [Not married]	1.54 .2	1.54 .2	1.3 .3	1.3 .3	1.5 .2	1.8 .09
Weekly working hours [full time]	13.1 < 0.005	12.4 < 0.005	19.5 < 0.005	25.9 < 0.005	28 < 0.005	19.4 < 0.005
CVA	.41 < 0.005	.3 < 0.005	.3 < 0.005	.57 < 0.005	.23 < 0.005	.34 (< 0.005

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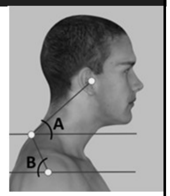
Discussion & Conclusion

- ❑FHP alters Central Conduction time.
- ❑FHP alters somatosensory processing.
- ❑FHP alters sensori-motor integration- N30.
- ❑Strong correlation between FHP and cervical sensorimotor integration and SEP.
- ❑ **Full time work increased the odds of having a higher amplitudes of SEPs and slower N13-N20 conduction.**
- ❑**Each 1 degree increase in the CVA (better FHP) was found to decrease the amplitudes of somatosensory processing potentials and resulted in a faster N13-N20 conduction time.**



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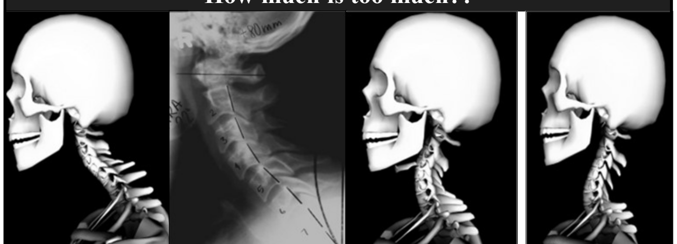
Is Anterior Head Translation a Subluxation?
How much is too much??



1. Flexion from C4-T1 Extension from C0-C3 2. Neutral Lordosis Circular shape 3. Flexion of C0-C4 Extension of C4-T1

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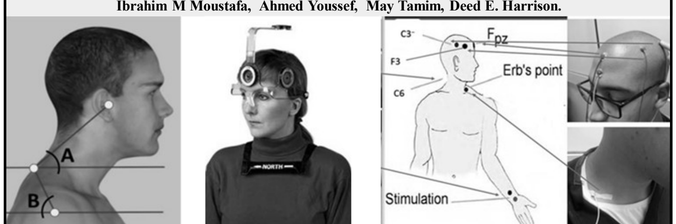
9. Sensorimotor integration, cervical sensorimotor control, and cost of cognitive-motor dual tasking: Are there differences in patients with chronic whiplash-associated disorder and chronic idiopathic neck pain compared to healthy controls? ESJ Sept 2022

Ibrahim M Moustafa, Ahmed Youssef, May Tamim, Deed E. Harrison.



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European Spine Journal
https://doi.org/10.1007/s00586-022-07390-w

ORIGINAL ARTICLE

Sensorimotor integration, cervical sensorimotor control, and cost of cognitive-motor dual tasking: Are there differences in patients with chronic whiplash-associated disorders and chronic idiopathic neck pain compared to healthy controls?

Ibrahim M. Moustafa[1,2] · Aliaa Diab[2] · Tamer Shousha[1,3] · Veena Raigangar[5] · Deed E. Harrison[4]

Received: 7 June 2022 / Revised: 12 August 2022 / Accepted: 12 September 2022

Abstract
Purpose The current investigation aimed to compare the sensorimotor integration, sensorimotor control, and cost of cognitive-motor dual task during walking, in persons with chronic WAD as compared to matched chronic idiopathic neck pain and normal healthy controls.
Methods A cross-sectional, case control design comparing 30 participants in each of two study groups (chronic WAD and chronic idiopathic neck pain) to a matched control group was conducted. Measurements included: (1) the cranio-vertebral angle (CVA), (2) left and right rotation head repositioning accuracy (HRA), (3) frontal N30 amplitudes to assess sensorimotor integration, (4) dual cognitive gait cost (DCGC).
Results A statistically significant difference for the CVA was found between groups: WAD 36.8° ± 3.4, chronic pain 44.5° ± 1.5, and controls 47.1° ± 4; $p < 0.05$. MANOVA revealed significant group differences for the N30 amplitude ($p < 0.05$), where the WAD group had the greatest amplitude. Statistically significant differences among the three groups were found for HRA left and right where the WAD group had the greatest error, ($p < 0.05$). Post hoc tests revealed that the WAD group had the highest dual-task cost during walking, ($p < 0.05$). Significant linear correlations between the CVA and N30 amplitude, HRA, and DCGC were identified in all 3 groups, ($p < 0.05$).
Conclusions Compared to both a matched control group and chronic neck pain group, whiplash-injured persons have greater forward head posture, greater error in sensorimotor control, and an altered ability to perform a motor task with a simultaneous cognitive task.

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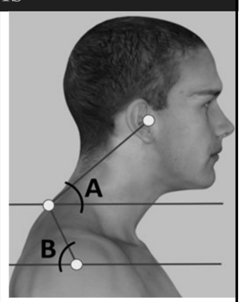
Study Hypothesis

- To evaluate differences in forward head posture, sensori-motor integration, sensorimotor control, and 7-Meter walking speed cognitive task cost in people with:

1. Chronic Whiplash Grade 2,
2. Chronic Idiopathic Neck Pain,
3. Normal controls strictly matched.

We hypothesized that WAD patients would have the greatest forward head posture leading to impaired sensorimotor control and increased cost of walking with a cognitive task.



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Design & Setting

Design: Pan African Clinical Registry.

Setting: University research PT Dept, Cairo, University.

Participants Case-Control:

- Study-30 subjects with WAD Grade II: 3-months to 1-year
- 30 Idiopathic chronic neck pain persons 3 months tp1 year
- 30 Controls no neck pain and history of trauma.

Matched for age-, sex-, and body mass index (BMI)-matched

Sample size & Stats:

1. 30 persons were needed in each group.
2. Multivariate analysis of covariance (MANOVA) group comparison
3. Pearson's r used to examine correlations between CVA amongst the 3-groups and main outcome variables.

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Kinesthetic Sense CROM Device: Head Repositioning Error (HRA)

30° to the right and left sides with three repetitions within a time-frame of 60 s in each. HRA= degree difference for the primary rotational plane of movement between the NHP reference and the return to NHP.

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Methods– 7 meter walking speed

1. Gait Speed Test was initially used to measure speed of walking 7 meters at normal pace.
2. Then, same 7-meter distance, participants were given a letter (e.g., S, T, or M depending on the day of the month they were born) and instructed to list as many animals as they could think of whose names began with that letter (i.e., Dual Task).
3. The cost of cognitive-motor dual tasking while walking was calculated using the equation:

(single gait speed — dual gait speed) /

÷

single gait speed x100

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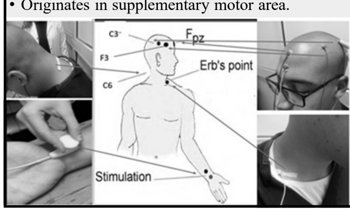
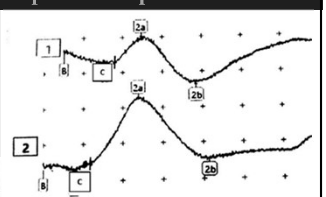
N30 Evoked Potential Amplitude Response

- **Amplitude:** Represents the degree of activity of its neural structures.
- **N30:** Functional connectivity of sensorimotor integration, which includes:
  - Thalamus, premotor area, basal ganglia and primary motor cortex.
- Originates in supplementary motor area.





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RESULTS: Group Differences

	WAD (N=30)	Idiopathic (N=30)	Control (N=30)
Age (years)	48 ± 2	47 ± 1	48 ± 2
Weight (kg)	91 ± 5	88 ± 4	89 ± 7
Gender (%)			
Male	10	10	10
Female	20	20	20
Smoking status			
Non smoker	20	19	22
Smoker	10	11	8
NRS pain intensity	5.5 ± 1	6 ± 1	-
Pain duration (weeks)	24 ± 2	25 ± 3	-
Cranio-vertebral angle (CVA)	36.8 ± 3.4	44.51 ± 1.5	47.12 ± 4
N30 (µV)	[redacted]	1.59 ± .33	1.31 ± .420
HRA (right rotation) (°)	[redacted]	2.37 ± .44	.35 ± .20
HRA (left rotation) (°)	[redacted]	2.37 ± .44	.35 ± .20
Cognitive cost %	[redacted]	25.7 ± 10.41	8.55 ± 7.20

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Pain Anxiety Symptom Scale Short Form 20 as a Measure of Psychological Stress Differences

	WAD (N=30)	Idiopathic pain (N=30)	Control (N=30)
Pain Anxiety Symptom Scale total score	42.2±6.1	39.5±6.9	Not conducted for this group

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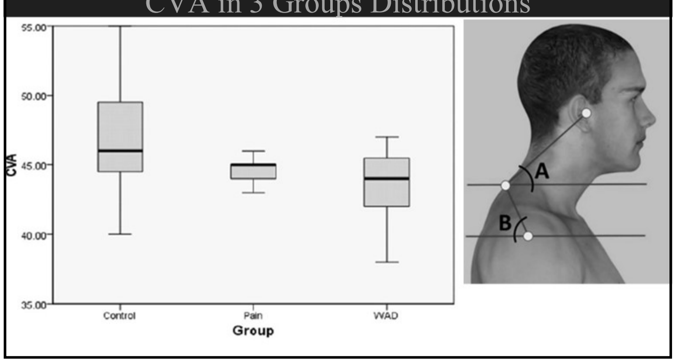
CVA in 3 Groups Distributions



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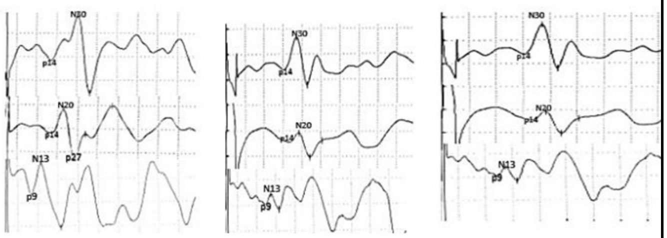
N30 Amplitude Differences



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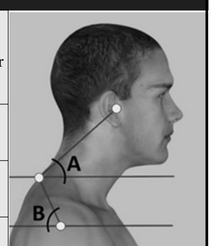
Correlations Between FHP & Variables

Correlation	WAD group Pearson's r P value	PAIN group Pearson's r P value	Control group Pearson's r P value
N30 amplitude	**-0.6 <0.001**	**-.5 .004**	**-0.39 0.02**
Cognitive cost during walking	**-.5 .004**	**-.4 <0.007**	**-0.6 <0.001**
HRA Right	-.47 <0.007	-0.41 .019	-0.21 .2
HRA Left	-.36 .004	-.50 .004	-0.6 <0.001



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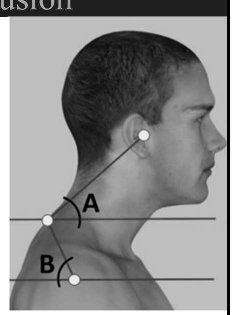
Discussion & Conclusion

- FHP negatively affects cervical sensori-motor integration- N30 Amplitude.
- FHP negatively affects sensori-motor control- Head repositioning accuracy.
- Forward head posture negatively affects dual task cognitive walking—Motor Control.
- There is strong correlation between FHP and sensori-motor integration, sensori-motor control, and dual task cognitive function.



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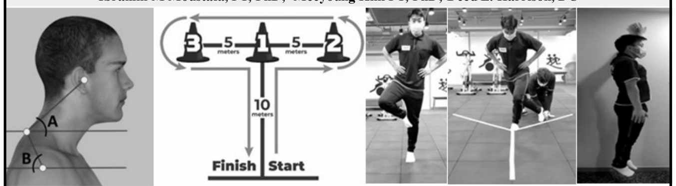
#7. Comparison of Sensorimotor Integration and Athletic Skill Tests Between Collegiate Athletes with and without Forward Head Posture

Ibrahim M Moustafa, PT, PhD; Meeyoung Kim PT, PhD; Deed E. Harrison, DC



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First Published Online: July 22, 2022

Human Kinetics
ORIGINAL RESEARCH REPORT

Comparison of Sensorimotor Integration and Skill-Related Physical Fitness Components Between College Athletes With and Without Forward Head Posture

Ibrahim Moustafa,[1,2] Meeyoung Kim,[1] and Deed E. Harrison[2,3]
[1]Department of Physiotherapy, College of Health Sciences, University of Sharjah, Sharjah, United Arab Emirates; [2]Neuromusculoskeletal Rehabilitation Research Group, Research Institute of Medical and Health Sciences, University of Sharjah, Sharjah, United Arab Emirates; [3]Ideal Spine Health, Eagle, ID, USA

Objective: To evaluate sensorimotor integration and skill-related physical fitness components for participants with forward head posture (FHP) compared with strictly matched controls with normal head alignment. ***Material and Methods:*** We measured FHP, sensorimotor processing, and skill-related physical fitness variables in 50 participants with FHP and in 50 participants matched for age, gender, and body mass index with normal FHP, defined as having a craniovertebral angle >55°. Sensorimotor processing and integration variables were: (1) amplitudes of the spinal N13, (2) brainstem P14, (3) parietal N20 and P27, and (4) frontal N30 potentials. The skill-related physical fitness variables selected for the study were (1) *T*-test agility, (2) leg power, (3) stork static balance test, and (4) *Y*-balance test. ***Results:*** There was a statistically significant difference between the FHP group and control group for the sensorimotor integration variable: frontal N30 potentials ($P < .05$). Additionally, between-group differences were found for the sensorimotor processing variables: amplitudes of spinal N13, brainstem P14, and parietal N20, and P27 ($P < .05$). Statistically significant differences between groups for the skill-related physical fitness variables were also identified: *T*-test agility, leg power, stork static balance test, and *Y*-balance test ($P < .05$). The magnitude of the craniovertebral angle showed a correlation with all measured variables ($P < .05$). ***Conclusion:*** College athletes with FHP exhibited altered sensorimotor processing and integration measurements and less efficient skill-related physical fitness compared with athletes with normal sagittal head posture alignment.

Keywords: sensorimotor control, agility, power, balance, cervical sagittal alignment

itation

1543-3072

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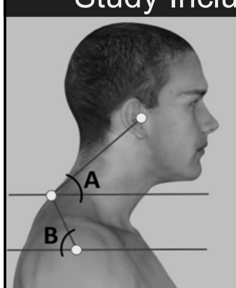
Study Inclusion & Exclusion Criteria



Forward Head Posture: A ≤ 50°

Controls: A ≥ 55°

I. Systemic pathology, including any inflammatory joint disease.

II. Prior history of apparent injury or surgery relating to the musculoskeletal system, or

III. Disorder connected to the spine and extremities.

IV. Musculoskeletal pain in the last 3- months.

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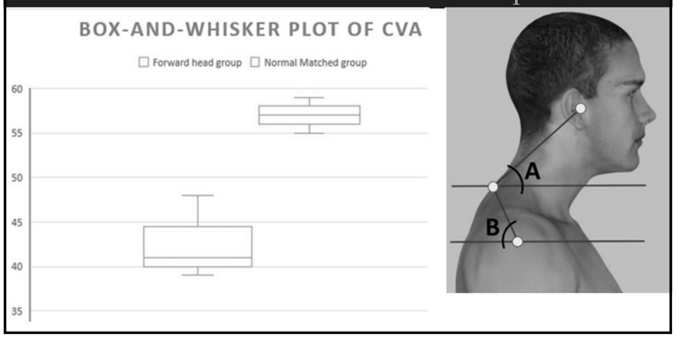
CVA in FHP vs. Control Groups



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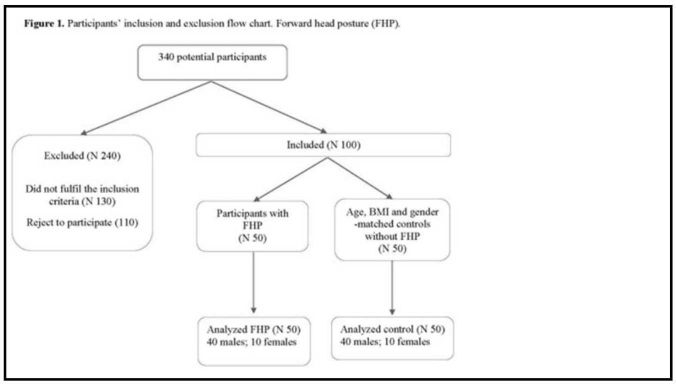

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Variable	FHP (n=50)	CG (n=50)
Age (years)	20.5 ± 2	20 ± 3
Weight (kg)	61.2 ± 4	62.2 ± 5
BMI	18.4 add SD here	18.3 add SD here
Gender (%)		
Male	40 (80%)	40 (80%)
Female	10 (20%)	10 (20%)
Sport,[a] Number in percent (%)		
Handball	20 (40%)	21(42%)
Volleyball	5 (10%)	5 (10%)
Basketball	25 (50%)	24 (48%)
P14	.96 ± .22	.68 ± .21
N20	2.4 ±.4	1.9 ± .27
P27	1.98 ± .27	1.64 ± .32
N30	2.6 ± .34	2 ± .41
N13	1.16 ± .16	.77 ± .10
Agility	8.89 ± .49	7.88 ± .51
Leg power	33.28 ± 2.9	42.14 ± 3.3
Stork Static Balance Test	45.5 ± 4.2	55.8 ± 4.3
Y-Balance Test	86 .07 ± 2.02	92.77 ± 2.36

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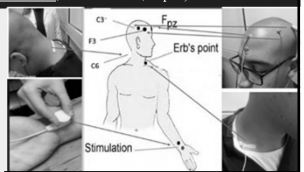
Neuro-Physiological Assessment

Electromyogram device (Neuropack S1 MEB-9400K, Nihon Koden, Japan)

- **N13** potential, at Cv6 (dorsal horn)
- **P14** potential, recorded over parietal and frontal electrodes-- nucleus cuneatus;
- **N20 and P27** potentials, contralateral parietal – primary somatosensory cortex;
- **N30** potential, frontal lobe and posterior wall of central sulcus.
- **N13-N20** Central Conduction



Band pass was set to 5–1500 Hz (−3 dB at the cutoff point, 6 dB per octave), analysis time of 100 msec and a ban width of 103 µsec. Stimuli were electrical square pulses of 0.2 msec duration A total of 800 sweeps were averaged. Each test was repeated at least twice.

- Stimulus 3 times above the sensory level.
- Recording electrodes (impedance below 5 kΩ) were placed over C6 spinous (Cv6),
- Parietal and frontal regions contralateral to stimulation (P3, P4, and F3, F4);
- Reference electrode at earlobe ipsilateral.

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The stork test was performed to assess static balance.[22] Participants stood on their dominant leg with their opposite foot leaning against their standing knee and with both hands on their hips. On the “go” signal, they raised the heel of the standing leg from the floor. The posture was held as long as possible. The test was terminated when the raised heel touched the ground, or when the opposite foot moved away from the standing knee.

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YBT Dynamic balance was assessed on the dominant leg. Participants' leg lengths were first determined while lying supine, measuring from the anterior superior iliac spine to the most distal aspect of the medial malleolus. They, then, stand on the dominant leg with the great toe placed at the center of installed floor marking tapes aligned in 3 directions (anterior, postero-medial, and postero-lateral). The 2 posterior lines extended at an angle of 135° from the anterior line. Participants were asked to reach in the 3 directions while maintaining a single-limb stance. The maximal reach was measured in each direction. The composite score (CS) was calculated as: CS = ([maximum anterior reach distance + maximum postero-medial reach distance + maximum postero-lateral reach distance] / [leg length × 3] × 100).[23] Three trials were conducted in each direction with a rest interval for 2-minute.

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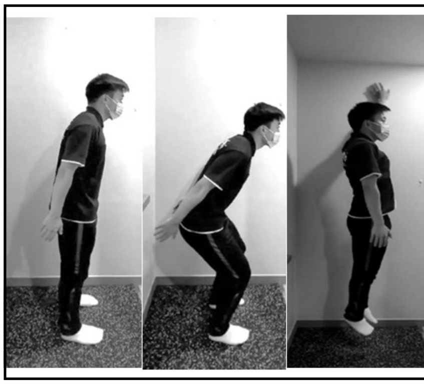

Leg power: Non-countermovement vertical jump test. Participants stood with their feet shoulder-width apart. They were asked to jump as high as possible after a brief squat pause with knees in 70° flexion. Participants marked their highest point of the jump using one hand on the wall. The average of 3 trials was recorded as the vertical jump height.

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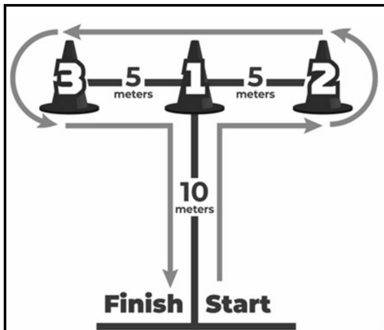

Agility T-test. Starting at the bottom of the T, the participant runs to the top center of the T (position 1). Next, from position 1, the participant shuffles to the right to position 2. Third, from position 2, the participant shuffles all the way across to their left to position 3. Fourth, the participant then shuffles from position 3 back to the position 1 at the center of the T. Finally, the participant runs backwards from position 1 to the start position (bottom of the T). The fastest trial of three attempts was recorded.

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Neurophysiological Outcome Measure	Mean Difference between groups‡	(95% CI)	Cohen's d	p-value
P14	0.28	[0.20 0.36]	1.36	<0.005
N20	0.42	[0.29 0.55]	1.46	<0.005
P27	0.43	[0.33 0.54]	1.14	<0.005
N30	0.6	[0.31 0.72]	1.59	<0.005
N13	0.39	[0.34 0.44]	2.9	<0.005
T-test agility	1.01 seconds	[0.83 1.2]	2.01	<0.005
Leg power	-8.86 cm	[-10.01 -7.6]	2.85	<0.005
Stork Static Balance Test	-10.3 seconds	[-11.8 -8.7]	2.40	<0.005
Y-Balance Test	-6.7 not simple	[-7.5 -5.9]	2.42	<0.005

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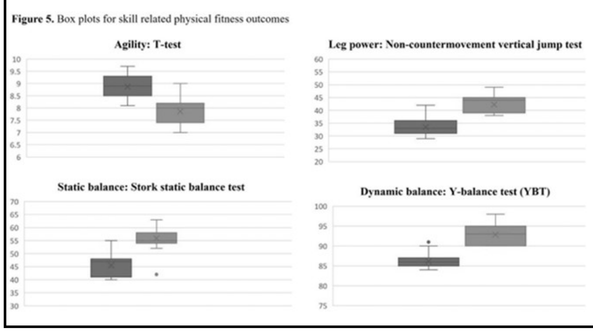
Blue: FHP **Orange:** Normal



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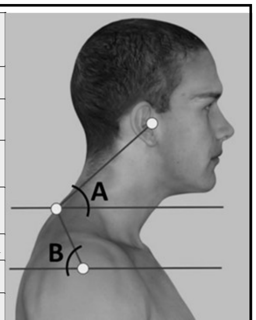
Correlation	CVA FHP r (p value)		CVA CG r (p value)	
N13	-.61	<0.001	-.49	<0.001
P14	-.52	<0.001	-.51	<0.001
N20	-.51	<0.001	-.50	<0.001
P27	-.5	<0.001	-.64	<0.001
N30	**-.69**	**<0.001**	**-.61**	**<0.001**
T-test agility	-.51	<0.001	-.53	<0.001
Leg power	.61	<0.001	.55	<0.001
Stork Balance Test	.71	<0.001	.58	<0.001
Y-Balance Test	.63	<0.001	.54	<0.001



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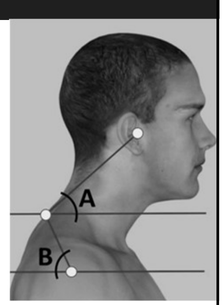
Key Findings

- Collegiate athletes with FHP exhibited altered sensorimotor processing and integration.
- Collegiate athletes with FHP exhibited less efficient athletic performance:
  - Stork Balance Test-Static;
  - Y-Balance Test—Dynamic;
  - Dynamic T-Test Agility Performance;
  - Leg Power-Vertical Leap.
- ❑ There is strong correlation between FHP and all athletic performance measures: Size Matters!
- ❑ FHP rehabilitation should be considered a key component of generalized athletic rehabilitation.



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Special Issue "Structural Rehabilitation of the Spine and Posture: Analysis, Techniques, and Outcomes in Clinical Research"

- Special Issue Editors
- Special Issue Information
- Keywords
- Published Papers

A special issue of *Journal of Clinical Medicine* (ISSN 2077-0383). This special issue belongs to the section "Clinical Rehabilitation".

Deadline for manuscript submissions: **29 February 2024** | Viewed by 279

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Dr. Deed Harrison E-Mail Website
Guest Editor
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Keywords

- posture alignment
- spine deformity
- reliability, assessments
- clinical outcomes
- clinical trials
- structural rehabilitation
- case control
- chiropractic
- physical therapy
- rehabilitative medicine

Published Papers

This special issue is now open for submission.

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#8

Article

Translational and Rotational Postural Aberrations are related to Pulmonary Functions and Skill Related Physical Fitness Components in Collegiate Athletes

May Tamim, PT, PhD; Ibrahim M. Moustafa, PT, PhD; Gobala K. Alaparthi, PT, PhD; Paul A. Oakley DC, MSc, PhD(c); Deed E. Harrison, DC *

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Conclusions

- Posture parameters, in terms of rotations and translations of the head, thorax and pelvis, were statistically correlated with physical performance skills and cardiopulmonary function.
- There were moderate-to-high associations with cardiopulmonary functions and agility tests, moderate correlations with the vertical jump test, and weak correlations with the YBT.
- Postural alignment may be important for optimal physical performance and optimal cardiopulmonary function. Further research is necessary to elucidate reasons for these correlations as found in our sample of young and healthy athletes.

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Are Rotations and Translations of Head Posture Related to Biomechanical Parameters in Three Different Dynamic Tasks?

Nabil Saad, PT;[1] Ibrahim M. Moustafa, PT, PhD;[1,2] Amal Ahbouch, PT, MSc;[1] Nour Mustafa Alsaafin, PT;[1] Paul A. Oakley DC, MSc, PhD(c);[3,4] Deed E. Harrison, DC[5]*

1 Department of Physiotherapy, College of Health Sciences, University of Sharjah, Sharjah 27272, United Arab Emirates;
2 Neuromusculoskeletal Rehabilitation Research Group, RIMHS–Research Institute of Medical and Health Sciences, University of Sharjah, Sharjah 27272, United Arab Emirates;
3 Independent Researcher, Newmarket, ON L3Y 8Y8, Canada
4 Kinesiology and Health Sciences, York University, Toronto, ON M3J 1P3, Canada
5 CBP Nonprofit (a spine research foundation), Eagle, ID, USA.
* Correspondence drdeed@idealspine.com ; drdeedharrison@gmail.com

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Demonstration of central conduction time and neuroplastic changes after cervical lordosis rehabilitation in asymptomatic subjects: a randomized, placebo-controlled trial

Ibrahim M. Moustafa[1,2], Aliaa A. Diab[2], Fatma Hegazy[1] & Deed E. Harrison[3]

A randomized controlled study was conducted to evaluate the effect of rehabilitation of the cervical sagittal configuration on sensorimotor integration and central conduction time in an asymptomatic population. Eighty (32 female) participants with radiographic cervical hypolordosis and anterior head translation posture were randomly assigned to either a control or an experimental group. The experimental group received the Denneroll cervical traction while the control group received a placebo treatment. Interventions were applied 3 × per week for 10 weeks. Outcome measures included radiographic measured anterior head translation distance, cervical lordosis (posterior bodies of C2–C7), central somatosensory conduction time (latency) (N13–N20), and amplitudes of potentials for spinal N13, brainstem P14, parietal N20 and P27, and frontal N30. Outcomes were obtained at: baseline, after 10 weeks of intervention, and at 3 months follow up. After 10 weeks and 3-months, between-group analyses revealed statistically significant differences between the groups for the following measured variables: lordosis C2–C7, anterior head translation, amplitudes of spinal N13, brainstem P14, parietal N20 and P27, frontal N30 potentials ($P < 0.001$), and conduction time N13–N20 ($P = 0.004$). Significant correlation between the sagittal alignment and measured variables were found ($P < 0.005$). These findings indicate restoration of cervical sagittal alignment has a direct influence on the central conduction time in an asymptomatic population.

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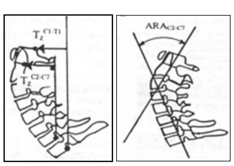
SUBLUXATION DEFINED HEREIN:

Inclusion Criteria- both Valid and Reliable

- Anterior Head Translation (AHT) more than 15 mm.
- Lordosis (ARA) less than 25°.
- No neuro-musculo-skeletal symptoms in previous 3-months.



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INTERVENTIONS

Experimental Group Denneroll Cervical traction

- Mid or lower cervical spine pending curve apex.
- 3 minutes per session, increased 1 minute per session until reaching the goal of 20 minutes.
- Repeated 3 x per week for 10 weeks.
- Interventions performed by the same therapist.
- Treating therapist was un-blinded to the treatment.
- Subjects and assessor who conducted the measurements were blinded.

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INTERVENTIONS

Control Group Received Placebo

- A small cervical towel was used as a placebo intervention. To mimic the denneroll traction without applying significant cervical extension.
- Applied 3 x per week for 10 weeks.
- Began at 3 minutes per session and increased 1-2 minutes per session until 20 minutes per session.

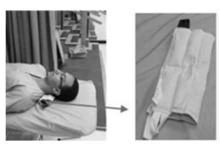

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Table 2.

Differences between treatment groups

Measure	Group	After 10 Weeks of Treatment			3-month, 10-Week Follow Up		
		Mean Difference‡	(95% CI)	P	Mean Difference‡	(95% CI)	P
AHT (Cm)	E vs. C	1.3	[1.09 1.4]	<0.005	1.2	[1.086 to 1.389]	<0.005
ARA (°)	E vs. C	-13.8	[-15.3 -12.2]	<0.005	-12.7	[-15.3 -10.2]	<0.005
P14	E vs. C	.34	[0.25 0.43]	<0.005	.31	[0.22 0.40]	<0.005
N20	E vs. C	.46	[0.33 0.59]	<0.005	.51	0.36 0.65]	<0.005
P27	E vs. C	.5	[0.37 0.65]	<0.005	.6	[0.41 0.68]	<0.005
N30	E vs. C	.49	[0.35 0.62]	<0.005	.45	[0.40 0.67]	<0.005
N13	E vs. C	0.2050	[0.11 0.29]	<0.005	.29	[0.21 0.38]	<0.005
N13-N20	E vs. C	.19	[0.06 0.32]	.004	.45	[0.32 0.57]	<0.005

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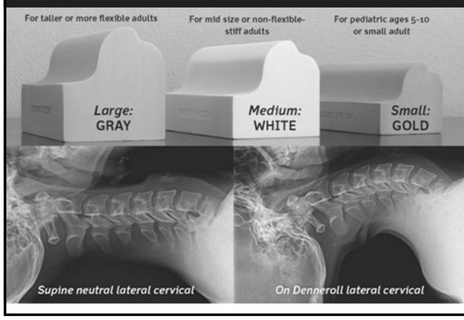
Denneroll Cervical Remodeling Orthotic



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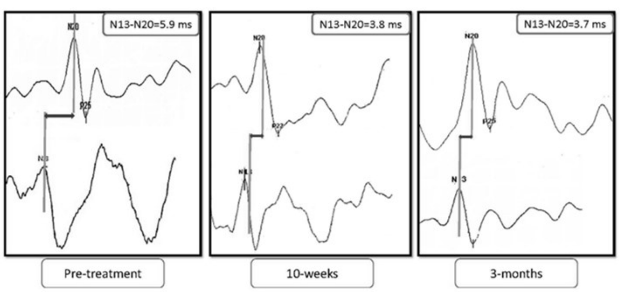

Figure 4. A representative example of central conduction time (N13–N20) at three intervals of measurement: baseline or pre-treatment, following 10-weeks of treatment, and 3-month follow-up. Time is shown in ms.

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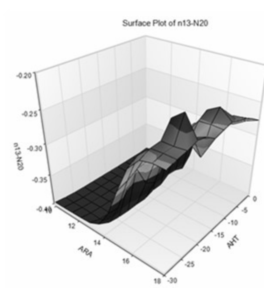
Multiple Regression Model:

Changes in ARA and AHT (10 -week-pre treatment) predict change in central conduction N13-N20

N13-N20 = -.729+.028(ARA) - 2.5(AHT)

- Central conduction Predicted by ARA & AHT
- $R^2 = 0.77$
- Adjusted $R^2 = 0.75$
- $P < 0.001$



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Measure	Group	Baseline mean (SD)	10-Weeks treatment mean (SD)	3-Month follow-up mean (SD)	10-Week versus baseline: Mean difference (95% CI)	P	Effect size Cohen d	Effect size r	3-Month versus baseline: Mean diff (95% CI)	P	Effect size Cohen d	Effect size r
AHT (Cm)	E	2.4 ± 0.4	1.01 ± 0.5	1.18 ± 0.5	1.3 [1.153–1.557]	<0.005	3.06	0.83	1.2 [0.97–1.40]	<0.005	2.69	0.8
	C	2.3 ± 0.3	2.27 ± 0.2	2.4 ± 0.12	.4 [− 0.02–0.10]	0.19	0.1	0.058	− 0.10 [− 0.16–0.046]	0.21	− 0.43	− 0.21
ARA (°)¤	E	4.16 ± 4.15	18.1 ± 2	17.9 ± 1.9	− 14 [− 14.7–13.24]	<0.005	− 4.2	− 0.9	− 13.78 [− 14.6–12.9]	<0.005	− 4.25	− 0.90
	C	4.2 ± 4.5	4.3 ± 4.4	5.1 ± 7.8	− 0.055 [− 0.17–0.059]	0.34	− 0.02	− 0.01	− 0.8925 [− 2.92–1.13]	0.38	− 0.14	− 0.070
P14	E	0.96 ± 0.21	0.68 ± 0.2	0.715 ± 0.18	0.27 [− 0.22–0.32]	<0.005	1.4	0.57	0.24 [0.21–0.27]	<0.005	1.36	0.564
	C	1.045 ± 0.24	1.03 ± 0.21	1.03 ± 0.2	0.015 [− 0.008–0.038]	0.2	0.04	0.02	0.015 [− 0.014–0.044]	0.3	0.06	0.033
N20	E	2.44 ± 0.4	2.01 ± 0.26	1.97 ± 0.25	0.43 [0.37–0.49]	<0.005	1.27	0.53	0.47 [0.415–0.52]	<0.005	1.40	0.57
	C	2.5 ± 0.38	2.475 ± 0.32	2.5 ± 0.4	0.037 [− 0.0075–0.082]	0.1	0.02	0.013	0.027 [− 0.01–0.066]	0.16	0.0	0.0
N27	E	1.9 ± 0.2	1.4 ± 0.32	1.49 ± 0.29	0.43 [0.32–0.52]	<0.005	1.96	0.70	0.41 [0.32–0.49]	<0.005	1.64	0.635
	C	2.02 ± 0.4	2.04 ± 0.3	2.045 ± 0.5	0.025 [− 0.023–0.073]	0.3	− 0.056	− 0.028	− 0.025 [− 0.045–0.004]	0.016	− 0.05	− 0.027
N30	E	1.9 ± 0.2	1.57 ± 0.3	1.57 ± 0.3	0.4 [0.3039–0.5061]	<0.005	1.29	0.543	0.4 [0.3145–0.4905]	0.007	1.29	0.543
	C	2.1 ± 0.3	2.06 ± 1.06	2.1 ± 0.3	0.03 [− 0.023–0.07]	0.27	0.156	0.07	− 0.027 [− 0.05–0.003]	0.03	0.21	0.107
N13–N20	E	5.7 ± 0.3	5.4 ± 0.4	5.2 ± 0.2	0.282 [0.20–0.36]	<0.005	0.84	0.39	0.44 [0.41–0.46]	<0.005	1.90	0.68
	C	5.6 ± 0.27	5.6 ± 0.28	5.7 ± 0.29	0.022 [− 0.003–0.04]	0.08	0.0	0.00	− 0.07 [− 0.13–0.013]	0.03	− 0.35	− 0.17
N13	E	1.2 ± 0.16	0.77 ± 0.09	0.68 ± 0.13	0.39 [0.35–0.43]	<0.005	0.8	0.37	− 0.4750 [− 0.5418–0.4082]	<0.005	3.57	0.87
	C	1.01 ± 0.24	0.97 ± 0.25	0.96 ± 0.22	0.035 [− 0.003–0.073]	0.07	0.1	0.08	0.03 [− 0.002–0.06]	0.069	0.21	0.107

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We Found we reduced N30 Amplitude after Spine Correction!!

Measure	Group	Baseline mean (SD)	10-Weeks treatment mean (SD)	3-Month follow-up mean (SD)	10-Week versus baseline: Mean difference (95% CI)	P	Effect size Cohen d	Effect size r
N30	E	1.9 ± 0.2	1.57 ± 0.3	1.57 ± 0.3	0.4 [0.3039–0.5061]	<0.005	1.29	0.543
	C	2.1 ± 0.3	2.06 ± 1.06	2.1 ± 0.3	0.03 [– 0.023–0.07]	0.27	0.156	0.07

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- https://webexercisesacademy.com/?s=deed+harrison
- www.IdealSpine.CE
- 10% off CBP Products—Online Only
- AAC2023

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Chapter

An Introduction to Chiropractic BioPhysics® (CBP®) Technique: A Full Spine Rehabilitation Approach to Reducing Spine Deformities

Deed E. Harrison and Paul A. Oakley

Abstract

Chiropractic Biophysics® (CBP®) technique is a full-spine and posture correcting method that incorporates mathematical principles into a unique approach to treat spinal disorders. It considers that the identification of postural rotations and translations of human postures are first evaluated and compared to the radiographic assessment of the spine alignment. Mirror image® postural positions and movements are utilized including spinal extension positions to improve the spine and posture towards a normal/ideal alignment. Specifically, corrective exercises, corrective traction and chiropractic adjustments are performed encompassing a multimodal rehabilitation program with the goal of improving the posture and spine alignment. CBP Rehabilitation programs are typically performed in-office with supportive at-home measures. Repeat assessment including radiographs are used to quantify and monitor structural improvements. CBP technique is an evidence-based approach to treat spine deformities and is supported by all forms of clinical evidence including randomized and non-randomized controlled trials, case reports/series as well as is supported by biomechanical posture-spine coupling validity, radiographic and posture analysis reliability/repeatability and use a validated biomechanical spinal model as the outcome goal of care. CBP technique is a proven method to improve pain, disability and quality of life in those with structural deformities.

Keywords: spine deformity, structural rehabilitation, traction, exercise, chiropractic

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2 General Categories of CBP Care

- **"Relief"or Restoration of Functional ROM**
  - 3-4 x week for 2-4 weeks until pain remises or improves and/or until ROM improves usually lasts 8-16 visits.
  - Patient comes back in if pain returns or ROM decreases.
  - **Treatment methods**: Segmental & global adjusting procedures, Stretching techniques, Myofascial techniques, Ice, Heat, etc…
- **CBP Structural Rehabilitation: 3 x wk for 12 or 4 x 9 wks**

Main Outcomes are Posture & Radiographic Alignment

Primary Treatment Methods:

A) Mirror Image Postural Exercises,

B) Mirror Image Adjustments,

C) Mirror Image Traction,

D) PNF Stretching in Mirror Image and Ergonomic Modifications

Once goals are achieved:

Patient is on maintenance/supportive care.

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CBP Goals of Care

1. **Normal AP & Lateral Posture**
   - Center of mass of head, rib cage & pelvis vertically aligned in AP and lateral views.
2. **Normal Spinal Alignment**
   - AP view: vertical alignment
   - Lateral: Harrison Ideal or Average Spinal Model
3. **Normal function (RoM, muscle strength, etc),**
4. **Health & Symptom Improvements:**
   - **Neck disability index,**
   - **Oswestry low back index,**
   - **SF 36 or Health Status Questionaire**

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The CBP Dr.'s Tool Box

Traditional Chiropractic Methods:

1) Segmental Adjusting (Improves Range of Motion & Relief),
2) Soft Tissue Mobilization (Relief),
3) Spinal & Extremity Stretching (Relief),

CBP Structural Rehabilitative methods:

1) Mirror Image® Spinal/Postural Adjustment
2) Mirror Image® Spinal/Postural Exercise
3) Mirror Image® Spinal/Postural Traction
4) Ergonomic Education/Life style Modification

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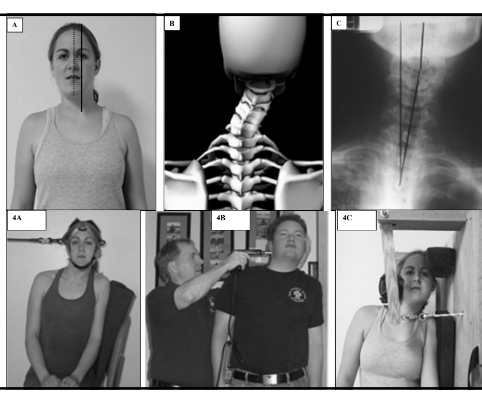

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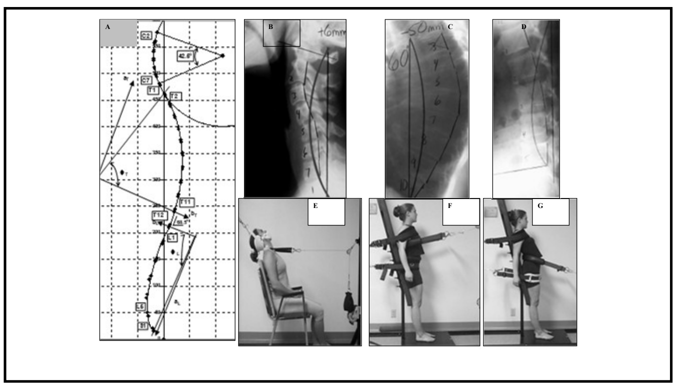

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Systematic Review of CBP® Methods Employed in the Rehabilitation of Cervical Lordosis
Fig 1. Examples of CBP® cervical extension traction and exercise methods in various studies.

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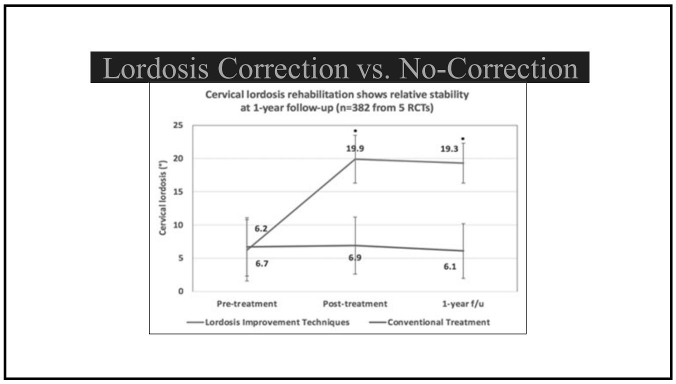
Lordosis Correction vs. No-Correction
Cervical lordosis rehabilitation shows relative stability at 1-year follow-up (n=382 from 5 RCTs)
Cervical lordosis (°)
25
20
15
10
5
0
19.9
19.3
6.2
6.7
6.9
6.1
Pre-treatment
Post-treatment
1-year f/u
Lordosis Improvement Techniques
Conventional Treatment

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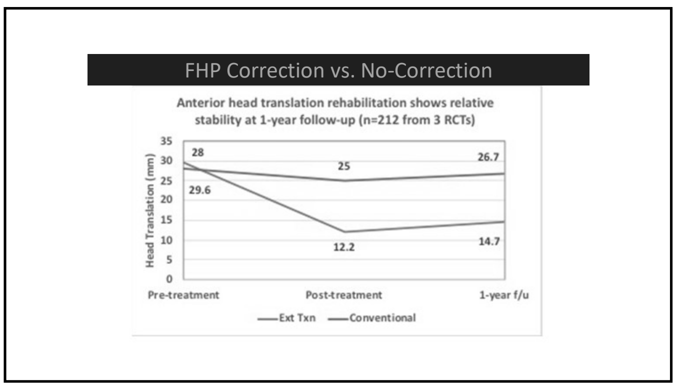
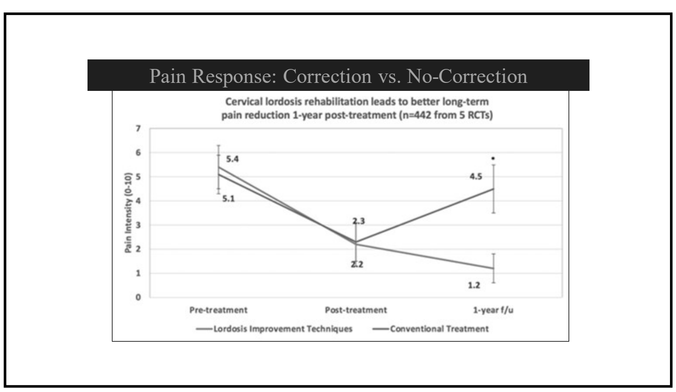

FHP Correction vs. No-Correction
Anterior head translation rehabilitation shows relative stability at 1-year follow-up (n=212 from 3 RCTs)
Head Translation (mm)
35
30
25
20
15
10
5
0
28
25
26.7
29.6
12.2
14.7
Pre-treatment
Post-treatment
1-year f/u
Ext Txn
Conventional

122


Pain Response: Correction vs. No-Correction
Cervical lordosis rehabilitation leads to better long-term pain reduction 1-year post-treatment (n=442 from 5 RCTs)
Pain Intensity (0-10)
7
6
5
4
3
2
1
0
5.4
5.1
2.3
2.2
4.5
1.2
Pre-treatment
Post-treatment
1-year f/u
Lordosis Improvement Techniques
Conventional Treatment

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CBP® Intervention

- From our publications, mirror image® exercises & traction procedures should be performed *in-office* at least 3-4 times per week for 9-12 weeks;
- Shown to achieve significant improvement in abnormal alignment of the spine and in patients' chronic disorder(s).1-5

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- https://webexercisesacademy.com/?s=deed+harrison
- www.IdealSpine.CE
- 10% off CBP Products—Online Only
- AAC2023

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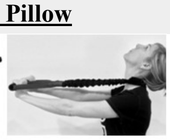
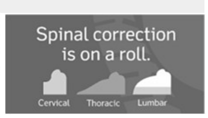
Home Care Equipment

- **Select appropriate Denneroll**
- **Pro-Lordotic for Cervical**
- **Stroops for at home**
- **Denneroll Pillow**





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Billing & Documentation for Denneroll as a Home Orthotic: Bill min. of $100.-$200.

- DME (durable medical equipment) Cervical Code
  - E0855 with
  - NU modifier---Indicating Separate and distinct sent home.
- Letter of Medical Necessity: See Deed's Ex. Fill Out
- Activities of Daily living eval: NDI for example
- Exact product description: Send Denneroll user guide & Both Patient and Doctor must SIGN user guide!
- **Send All of Above in for Completeness!**

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"Other" Codes for Denneroll DME

- **97535** – Self Care "instructions for use of assistive technology devices/adaptive equipment" for the purpose of instruction in managing his or her injury at home and preventing secondary injury
- **97760** – "Orthotics fitting for upper extremities, lower extremities and/or trunk. Any training time associated with using the orthotic may be reported using 97760"

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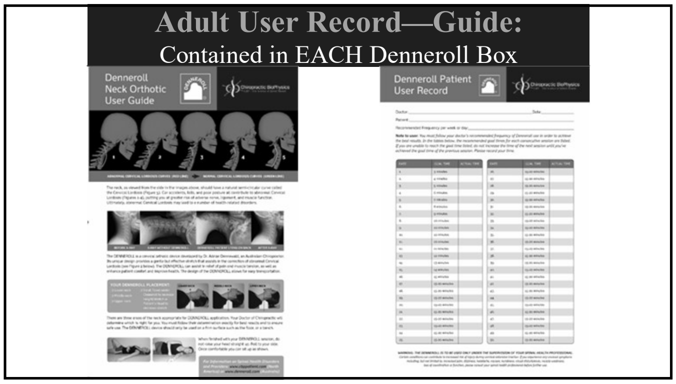
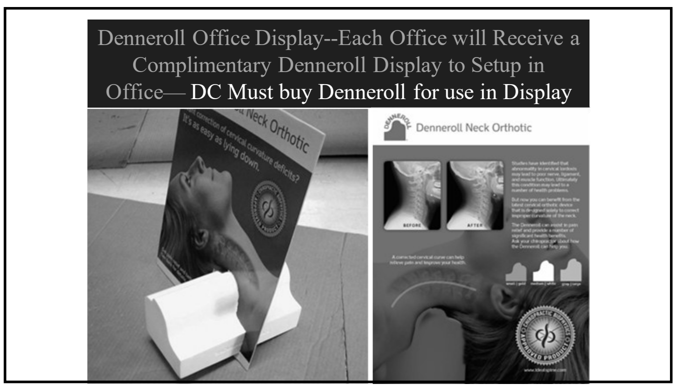

Adult User Record—Guide:
Contained in EACH Denneroll Box
Denneroll Neck Orthotic User Guide
Denneroll Patient User Record

130


Denneroll Office Display--Each Office will Receive a Complimentary Denneroll Display to Setup in Office— DC Must buy Denneroll for use in Display
It's as easy as lying down.
Denneroll Neck Orthotic

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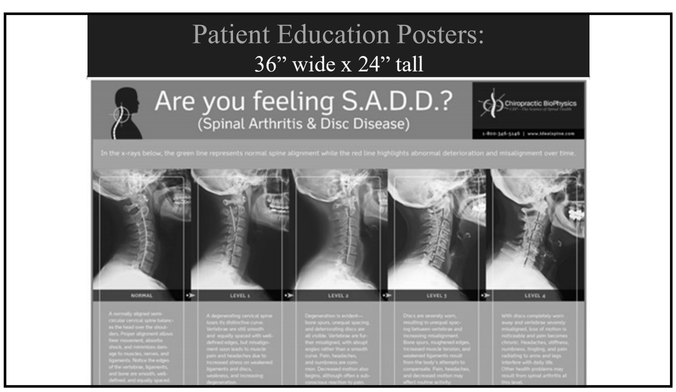
Patient Education Posters:
36" wide x 24" tall
Are you feeling S.A.D.D.?
(Spinal Arthritis & Disc Disease)
Chiropractic BioPhysics
NORMAL
LEVEL 1
LEVEL 2
LEVEL 3
LEVEL 4

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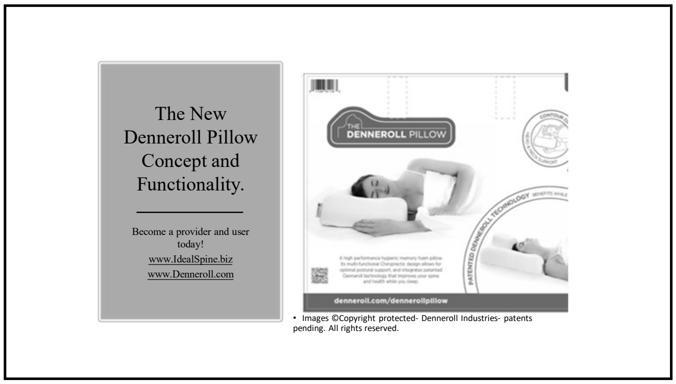
The New Denneroll Pillow Concept and Functionality.
Become a provider and user today!
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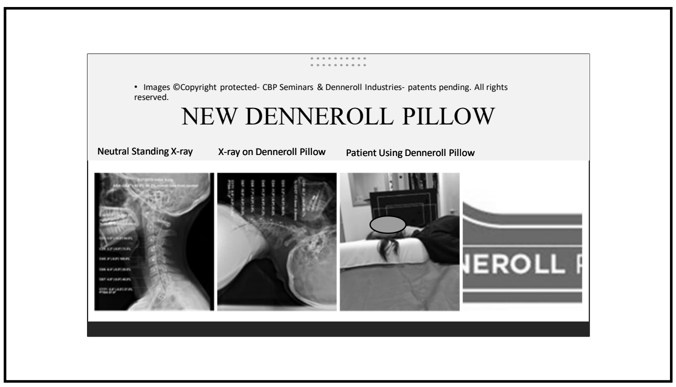
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NEW DENNEROLL PILLOW
Neutral Standing X-ray
X-ray on Denneroll Pillow
Patient Using Denneroll Pillow

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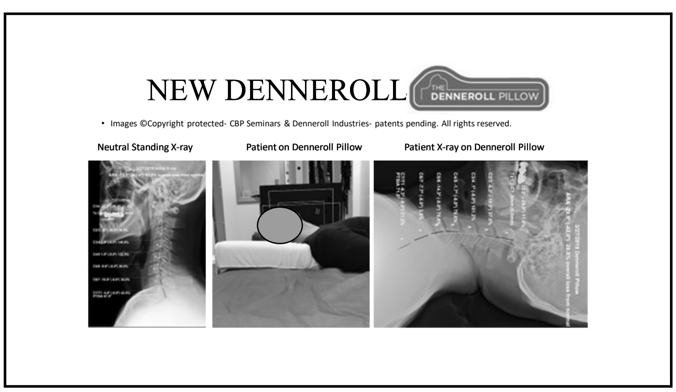
NEW DENNEROLL
THE DENNEROLL PILLOW
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Neutral Standing X-ray
Patient on Denneroll Pillow
Patient X-ray on Denneroll Pillow

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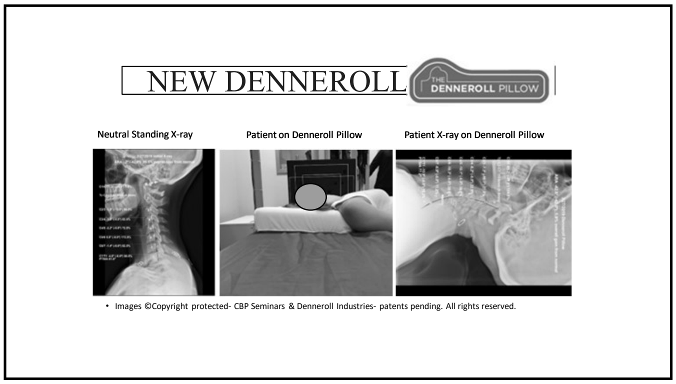
NEW DENNEROLL
THE DENNEROLL PILLOW
Neutral Standing X-ray
Patient on Denneroll Pillow
Patient X-ray on Denneroll Pillow
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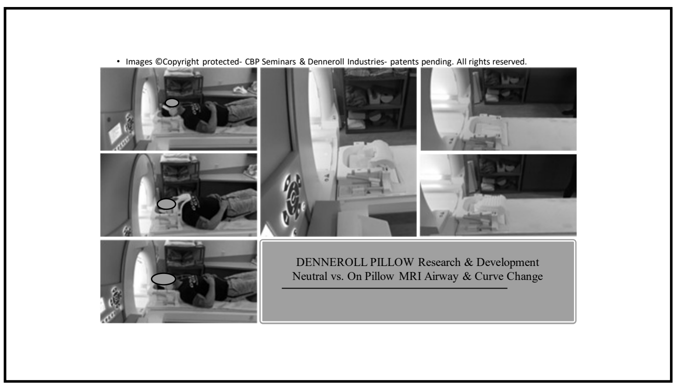
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DENNEROLL PILLOW Research & Development
Neutral vs. On Pillow MRI Airway & Curve Change

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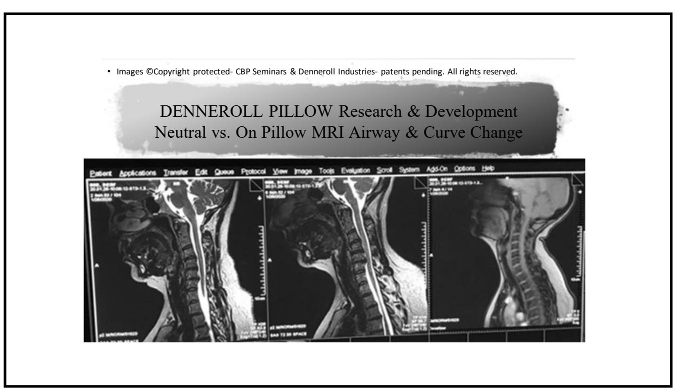
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DENNEROLL PILLOW Research & Development
Neutral vs. On Pillow MRI Airway & Curve Change

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Denneroll Pillow: Improved Airway Diameter > 30% Larger

On Denneroll Pillow-Open Airway Standard Pillow –Closed Airway

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NEW PEDIATRIC PILLOW

Neutral Standing X-ray

Patient X-ray on Denneroll Pillow

THE DENNEROLL PILLOW

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Concussion

- Whiplash WITHOUT head trauma
  - Cause of Concussion
  - Research Lacking
- PubMed Database searches:
  - Concussion – ~15,000 results
  - Whiplash – ~4,000 results
  - Concussion AND Whiplash – ~100 results
  - Concussion AND Cervical Spine – ~190 results
  - Concussion AND Cervical Curve – 8 results
  - Concussion AND Cervical Lordosis – No Results

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Improvement in Post Concussion Syndrome Symptoms and Disabilities and Decrease in Concussion Incidence in a Professional Rugby Player Following Improvement in Cervical Spinal Alignment Using CBP®: A Case Study and 6-Year Follow-up.

Seth Strauss, DC[1], Douglas F Lightstone, DC[2], Curtis Fedorchuk, DC[2],,
Paul Oakley, DC, MSc[3], Robert Pomahac, DC[2], Deed E Harrison, DC[3]
[1]Private Practice, Mount Pleasant, SC, USA
[2]Institute for Spinal Health and Performance, Cumming, GA, USA
[3]CBP® Nonprofit, Eagle, ID, USA

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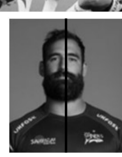
Patient Presentation

- 27-year-old male
- Neck Pain, Headaches, Dizziness, Cervical Radicular Pain, Abnormal Posture
- Professional Elite Rugby Player (National Team)
  - 20 diagnosed concussions over 6 years as a pro rugger prior to CBP®



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Patient History

- MRI - Normal
- Not all concussions resulted from head trauma
- Playing with PCS symptoms
- Previous treatments ongoing throughout career
  - Physical Therapy
    - Modalities
    - PT Exercises & Therapies
  - Traditional Chiropractic Adjustments
  - Ineffective

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Results

NLC radiographs with HPTM Analyses (red); Ideal (green).
Left. Initial NLC radiograph; ARA C2-C7 = -13.5˚
Middle. 16-day follow-up NLC radiograph; ARA C2-C7 = -37.4˚
Right. 2-year follow-up NLC radiograph; ARA C2-C7 = -34.7˚.

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CBP Mirror Image Methods Used

ProLordotic Exercise
Pope-2-way
Extension Traction
Denneroll Traction

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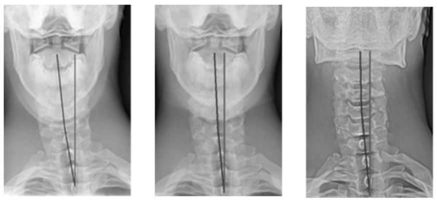
Results



APLC radiographs with Analyses (red); Ideal (green).
Left. Initial APLC radiograph; Tx C2-T3 = -22.7 mm.
Middle. 16-day follow-up APLC radiograph; Tx C2-T3 = -11.3 mm.

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1) Skull shifted on one side. **2) Eyes are level**
3) Median-sagittal plane remains vertical **4) Both ears are visible**
5) Symphysis menti on the right of the epi-sternal notch
6) Opposite shoulder is sometimes higher

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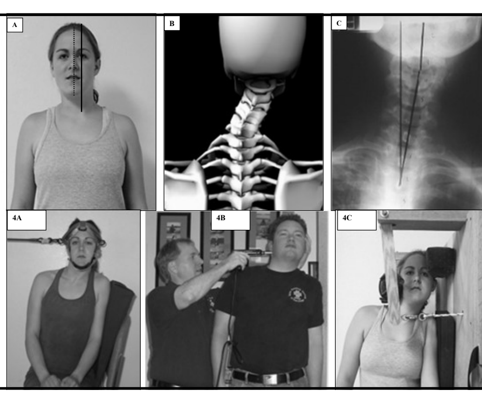

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Patient Outcomes

- 30 visits of CBP® over 16 days
- Cervical spine correction
  - Improved PCS symptoms
  - Improved NP and disability
  - Improved HA pain and disability
  - Improved QOL.
  - Prevent/minimize concussions?
    - 2 diagnosed concussions in 6 years following CBP®

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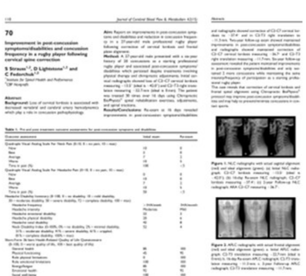
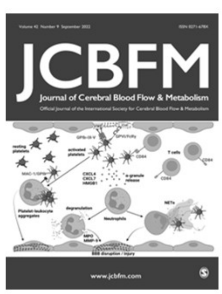
Conference Proceedings





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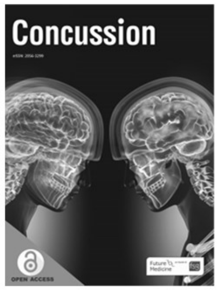
Published in Concussion



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