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Original Article

Agreement of Upright and Supine Measurements of Active Cervical Rotation

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Abstract:

Background: Cervical active ROM measurements in flexion/extension and lateral flexion appear to be universally obtained with the subject in the upright position, regardless of the measurement device being utilized. However, measurement of cervical active rotation has been measured in either the upright or supine positions, depending on the technological capabilities of the measuring device being utilized. Supine and upright measures of active cervical range of motion may not provide interchangeable results. The goal of this study was to compare such measurements using devices commonly used in clinical practice.

Methods: Active cervical rotation of 32 participants was measured in the upright and supine positions. A series of 3 upright measurements were obtained using a single magnetic compass-oriented goniometric device, and 3 supine measurements with a single gravity-dependent goniometer device.

Results: Intra-examiner, intra-instrument reliability ranged from ICC (2,1)=0.876 to 0.912, rated “almost perfect.” The mean inter-examiner, inter-instrument reliability for left rotation was ICC (2,2) = 0.255 (“poor”); and for right rotation ICC (2,2) = 0.492 (“moderate”). Supine measurements were consistently greater than upright measurements, by an average of 24.4° in left rotation and 15.0° in right rotation. A paired samples-t test revealed a statistically significant difference between supine and upright measures.

Conclusions: Upright measurement of active cervical rotation does not provide information interchangeable with supine measures. Since the assessment of sagittal and frontal plane cervical movements is routinely done in the upright position, where functional disability is most likely to manifest, it stands to reason that transverse plane cervical movements (rotation) might best also be assessed in the upright position. This would most likely lead to a more

accurate functional diagnosis. To ensure consistency of interpretation of active cervical rotation in research and clinical settings, it is important to consider the position in which active cervical rotation is measured. The position used may furthermore impact upon impairment ratings.

Keywords: Active, Range of Motion, Cervical Vertebrae, Reproducibility of Results, Reliability, Spine

Introduction

Range of motion (ROM) is a valuable diagnostic tool and primary outcome measure utilized in the determination of effectiveness of clinical intervention for many neuromusculoskeletal conditions affecting the spine. In both clinical and research settings accurate, efficient, and reproducible measurement of ROM is essential to objectify extent of injury, quantify the level of disability, and monitor response to treatment.¹⁻¹²

The measurement of cervical active ROM in research studies and clinical practice has been performed using numerous relatively simple tools and methods: visual estimation, tape measurement, hand-held universal goniometer, liquid goniometer, bubble or gravity-dependent goniometer, an ad modum Myrin (using 2 gravity inclinometers and a compass), and optical motion analysis.¹³ More advanced inclinometer methodologies utilizing multiple inclinometers/goniometers, electromagnetic technology,

ultrasonographic devices, electronic digital inclinometers, potentiometers, and radiographic analysis to measure ROM have also been studied^{5, 13} but appear less commonly used in routine clinical practice. Most recently, apps for smart phones have become available for inclinometry¹⁴.

Cervical active ROM measurements in flexion/extension and right/left lateral flexion appear to be universally obtained with the subject in the upright position, regardless of the measurement device being utilized^{5, 13, 15, 16}. However, measurement of cervical active rotation has been measured in either the upright^{1, 8, 12, 14, 17-19} or supine positions^{13, 20-24}, depending on the technological capabilities of the measuring device being utilized. Several literature reviews have addressed the intra-examiner and inter-examiner reliability of the various specific measuring devices, as well as the between-instrument agreement of several different devices^{5, 13, 16, 20}. These studies have usually been stratified by demographic characteristics of the participants: gender, age, and clinical status.

To measure active cervical rotation using the same gravity-dependent device that has been used to measure flexion, extension, and lateral flexion, the patient or participant must be measured in the supine position, with the device on the forehead²⁵. That stated, there are several inexpensive and readily available devices that permit measurement of active cervical rotation in the upright position. These devices include

the universal goniometer, a magnetic compass, or a smart phone^{13, 14}.

The primary goal of this study was to compare measurement of active cervical rotation in the upright position with active cervical rotation in the supine position using methods and devices commonly used in clinical practice. Other studies that compared upright and supine active cervical rotation²⁶⁻³¹ included sagittal and frontal plane measurements as well. Measuring these other planes of movements in the same session as rotation may influence the rotation values, depending on the order in which the measurements are made. Therefore, in the interest of meeting the study's primary goal and avoiding confounding factors, the authors measured only rotation. Ultimately, this would best address the question of whether supine and upright measurements provide interchangeable clinical data, with possible implications for impairment ratings and other medico-legal situations.

Methods

Study personnel and participants

This study was approved by the Institutional Review Board of the college where it was conducted, conforming to the Helsinki Declaration, and all participants provided informed consent. A convenience sample of college students was recruited, none of whom were compensated in any way for their participation. The inclusion criteria were that the participants were required to

be asymptomatic or have cervical pain ≤ 2 on a 0-10 scale on the day of investigation. Data were collected by two separate experienced examiners, each of whom has been teaching the use of goniometric devices in the college's orthopedics program for several years. A third investigator facilitated the directing of participants to each of the 2 measuring stations in randomized order.

Measuring equipment

Upright measurements were obtained using a compass goniometer (figure 1) and supine measurements using a gravity-dependent inclinometer (figure 2). One investigator measured participants in the upright position, while the other investigator measured participants in the supine position. Upright measurements were made with the participant stabilized by a strap tightened diagonally across the chest to minimize extraneous torso movements.



Figure 1. Seated measurement using compass goniometer

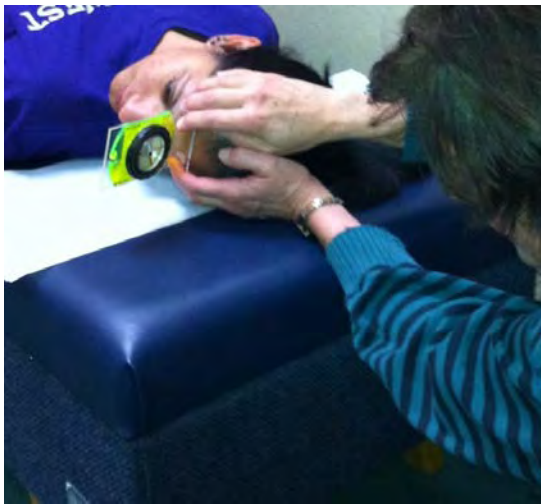


Figure 2. Supine measurement using gravity-dependent inclinometer

Experimental Procedure

Study participants sat in a holding area where they filled out informed consent and demographic information forms. When these were completed, the participants were interviewed by an independent examiner to determine if inclusion criteria had been met. Participants who met the inclusion criteria were randomly assigned to their first evaluation station by drawing a concealed assignment slip from an envelope. Half the participants were first evaluated in the seated upright position and the other half first in the supine position. Following the first measurement, participants were directed to a holding area where they were required to sit quietly during a five-minute washout period before being measured in the other position.

The examiner that measured upright active cervical rotation used a compass goniometer. A headband was placed on the subject's head so that the goniometer could

be secured at the top of the head, and the device was tared to zero. The participant was instructed as follows: "Turn your head to the right/left as far as you comfortably can." Following measurement of active ROM, the participant was asked to return his/her head to a centered position. This procedure was repeated in the opposite direction. A total of three measurements were recorded in relatively rapid succession for each direction of upright active cervical rotation.

The examiner that measured supine active cervical rotation used a gravity-dependent inclinometer. The participant was instructed to lie supine on an examination table. The inclinometer was placed on the participant's forehead and tared to zero. The examiner used their fingers to firmly secure the inclinometer to the participant's forehead. The instruction was as follows: "Turn your head to the right/left as far as you comfortably can." After the examiner recorded the range of motion, the head and neck were returned to a centered position. This procedure was repeated in the opposite direction. A total of three measurements were recorded in relatively rapid succession for each direction of supine active cervical rotation.

Data Analysis

The data are provided descriptively as ranges of motion measured in degrees. Statistical analysis included intra-class correlation coefficients (ICCs) for both intra-examiner and inter-instrument

reliability; paired t-testing assuming unequal variance to determine if upright and supine measures of active cervical rotation were different; and the inter-instrument Pearson product-moment correlation.

Results

Thirty-four adult volunteers provided informed consent and completed a research participant questionnaire to determine eligibility for the study and provide demographic information. Thirty-two participants met the inclusion criteria, evenly split into 16 males and 16 females, ranging in age from 23 to 51 years (mean: 27.6 years).

Table 1 reports the values for upright and supine left and right rotation. It provides the 32-participant mean values for the first, second, and third measurements, as well as the upright and supine 3-measurement grand means. The grand mean of supine left rotation exceeded right rotation by 7.1^0 ; whereas the grand mean of upright left measures fell short of rotation to the right by 2.3^0 . The supine measurements were consistently greater than the upright measurements, by 24.4^0 in left rotation and 15.0^0 in right rotation. Table 2 reports the intra-examiner and inter-instrument reliabilities.

Table 1. Mean ROM Measurements of Active Cervical Rotation

	Left	Right
Supine Measurement #1	89.9 ⁰	82.7 ⁰
Supine Measurement #2	89.8 ⁰	82.2 ⁰
Supine Measurement #3	89.5 ⁰	83.0 ⁰
Grand Mean (Supine)	89.7⁰	82.6⁰
Upright Measurement #1	64.6 ⁰	67.2 ⁰
Upright Measurement #2	65.7 ⁰	67.4 ⁰
Upright Measurement #3	65.8 ⁰	68.4 ⁰
Grand Mean (Upright)	65.3⁰	67.7⁰

Table 2. Intra-examiner / inter-examiner, inter-instrument reliability coefficients

	Left	Right
Intra-examiner, intra-instrument (3 measures)		
Supine ICC (2,1)	0.912	0.876
Upright ICC (2,1)	0.896	0.884
Inter-examiner, inter-instrument		
ICC (2,2)	0.255	0.492

A paired samples-t test revealed a statistically significant difference between supine left (mean = 89.7 degrees, SD=10.7) and upright (mean = 65.3 degrees, SD = 7.3) rotation: $t(31) = 18.1$, $p=.000$, $\alpha=.05$. Likewise, a paired samples t-test revealed a statistically reliable difference between supine right (mean = 82.6 degrees, SD=11.5) and upright (mean = 67.7 degrees, SD=7.7) rotation: $t(31) = 11.14$, $p=.000$, $\alpha=.05$.

The Pearson product-moment correlation was obtained for supine vs. upright measures: left rotation, $r = 0.704$ (0.471, 0.8453); right rotation, $r = 0.758$ (0.556, 0.875)

Discussion

The number of participants used in this study was based upon the work of Eliasziw et al³². According to these authors, it would be reasonable to consider ICC=0.6 minimally acceptable for inter-instrument reliability, and ICC=0.8 minimally acceptable for intra-examiner reliability. The sample size required at the 5% significance level with 80% power, for 3 repeated measures, was 35 participants if true ICC=0.90. This power calculation was applied to the intra-examiner module of this study. For the inter-instrument module of this study, approximately 35 subjects were required to yield 80% power for hypothesis testing if true ICC=0.80. Although the actual number of participants successfully recruited and eligible for this study was only 32, this

small short-fall reasonably conformed to the power calculations.

The intra-examiner, intra-instrument reliability ICC values for both the upright and upright positions was judged to be “almost perfect” in accordance with the Landis and Koch interpretation scale: poor to fair (below 0.4), moderate (0.41–0.60), excellent (0.61–0.80), and almost perfect (0.81–1)³³. This high reliability is consistent with many other intra- and inter-examiner reliability studies^{5, 13, 15, 16}. By comparison, the ICC values for inter-examiner, inter-instrument reliability were judged “poor” for left rotation and “moderate” for right rotation. This relatively lower inter-instrument agreement for supine and upright measures is also consistent with the other studies that measured both²⁶⁻³¹. Confidence intervals are not given for the reliability estimates because such calculations are misleading when the number of raters is small and the rater effect is not negligible. According to Roussan et al, intervals produced by existing methods are uninformative: the lower bound is often close to zero, even in cases where the reliability is good and the sample size is large³⁴. Consistent with the ICC results, paired sample t-testing demonstrated that the means of supine and upright cervical ROM (left and right) were statistically different at the 95% confidence level. Student t-testing in this study requires rejection of the null hypothesis that the means of the supine and upright measures are the same.

At first glance the Pearson product-moment values seem to suggest a close relationship between the supine and upright measures, with $r = 0.704$ on the left, judged “moderate to good” on the Portney-Watkins scale;³⁵ and $r = 0.758$ on the right, judged “good to excellent.” However, looks can be deceiving: high *correlation* is not equivalent to high *agreement*^{36,37}. It is not surprising that a high value for one measure predicts a high value for the other. The relatively high correlation seen in this study simply suggests that relatively large rotation values measured in one position predict relatively high rotation measures in the other, even though the magnitudes are different.

Of the 5 active cervical rotation studies that included both upright and supine measures

(table 3), other than the study by Luu and Lantz³¹ involving only 2 participants, the present study is the only one that exclusively measured cervical rotational ROM. The others²⁶⁻²⁹ measured rotation in all 6 degrees of freedom. In all 5 studies, the supine rotational measures exceeded the upright measures. In addition to their $n=2$ pilot study included in table 2, Lantz and Luu performed a $n=30$ study³ including active cervical rotation in the upright and supine positions. Since it appears to have been published only as a conference abstract, it was not included in table 3. Consistent with the other studies, the authors reported that “axial rotation with subjects supine is substantially greater than those with subjects upright.

Table 3. Studies comparing upright and supine measures of ACR

Study	Device used	Upright ROM	Supine ROM	Agreement			
				Right	Left	Right	Mean L/R reliability
	Upright	Supine	Left	Right	Left	Right	
Luu [31]	Electrogoniometer	Potentiometer inclinometer	75.9	73.3	99.4	100.2	not relevant (n=2)
Chaves [26]**	universal goniometer	Gravity inclinometer	59.49±6.56	59.46±7.08	83.33±7.64	80.79±8.93	$r=0.18$ (L)*; $=0.38$ (R)
Hole [27]	Compass (CROM)	Gravity inclinometer	71.8 (10.4)	60.2 (11.9)	Greater than upright measures; values not provided		ICC= -0.12 (L); -0.23 (R)
Prushansky [28]	Ultrasound (Zebris)	Gravity inclinometer	70.9 ± 6.0	70.0 ± 5.5	76.3 ± 3.5	74.5 ± 5.7	$r=0.27^*$ (L); 0.58^* (R)
Tucci [29]	Universal goniometer	Gravity inclinometer	79.7 6.8	78.8 8.0	80.5 5.2	80.2 7.4	ICC=0.38 (L); 0.49 (R)
*not significant ** age 11-14							

Prushansky, comparing the results obtained with the upright ultrasonography-based Zebris goniometer and a supine digital inclinometer, concluded: “No significant differences were revealed between the two instruments with respect to the sagittal and frontal planes, whereas the DI-based CROM in rotation was significantly greater than [sic] its Zebris-based counterpart . . . device interchangeability may not be extended to this plane”²⁸. Echoing this point, Hole et al state this “illustrates the importance of standardization of patient positioning in all cervical and spinal range of motion measurements”²⁷. Finally, Lantz and Luu suggest upright and supine measures of active cervical rotation are not only quantitatively but also qualitatively different, perhaps owing to a hypothetical neurologically-mediated proprioceptive effect accruing to the supine position³.

A comprehensive measurement of cervical ROM involves taking 6 measurements: left lateral flexion, right lateral flexion, forward flexion, extension, left rotation, and right rotation. Although the statistical analyses that are ultimately performed generally assume the independence of observations, the logistics of data acquisition strain the credulity of that assumption, since it is simply not feasible to provide a washout period of several minutes (at the least) between each of the 6 observations. It cannot be ruled out that having the participant move his or her neck in a given direction impacts soft tissues, perhaps mediated by the nervous system, altering other measurements to be obtained²⁴. These

other measurements could conceivably be increased, due to soft tissue stretching; or decreased, through the activation of stretch reflexes or provocation of joint structures even when asymptomatic at the baseline neutral position.

Pain and dysfunction of mechanical origin is often position-dependent. A patient who experiences kinesiopathy in a weight-bearing position may experience less discomfort in a non-weight-bearing posture, including supine. The relatively increased ranges for active cervical rotation in the supine position apparently reflect the position-dependent benefits of decreased weight-bearing on the anterior and/or posterior zygapophyses. Since the assessment of sagittal and frontal plane cervical movements is routinely done in the upright position, where functional disability is most likely to manifest, it stands to reason that transverse plane cervical movements (rotation) might best also be assessed in the upright position. This would most likely lead to a more accurate functional diagnosis.

Position-based differences in measured cervical range of motion could impact upon impairment ratings in some settings, despite lack of support for that practice by the American Medical Association. On the one hand, various insurance companies, most workers’ compensation cases, and motor vehicle accident litigators use the impairment rating system set out in the American Medical Association’s (AMA) Guides to the Evaluation of Permanent Impairment, Sixth Edition, to calculate

compensable levels of impairment^{38,39}. According to the Guides, clinical progress can be monitored by range of motion assessment, but range of motion is not considered a reliable indicator of specific pathology or permanent functional status; thus it cannot be used to define impairment⁴⁰. On the other hand, the authors, residing in California, would like to note that the California Workers' Compensation system does not utilize the AMA Guides in their strictest sense, and has created its own guidelines wherein range of motion is assessed and documented, together with the identification of the type of measurement utilized and the reason of limitation of the range of motion, be it pain or tightness or spasm. For example, work capacity can be used as an index which "contemplates the individual has lost approximately 50% of pre-injury capacity" for flexion, extension, lateral flexion, and rotation of the neck which results in a Standard Rating of 15%³⁹.

Limitations

The examiners recorded their own data and thus were not masked to the results of previous measures during the recording of the 3 measurements. Therefore expectation bias could not be excluded as a factor influencing outcome of measurements. The investigator measuring supine active rotation held the measurement device in place with their fingers, potentially introducing measurement bias. The participants in this study were almost all relatively young, minimally or non-symptomatic college

students. The results may have been different if the measurements had been taken on a symptomatic population, or on participant pools stratified by age.

Conclusion

Measurement of active cervical rotation obtained in the upright position does not demonstrate agreement with the measurement of active cervical rotation obtained in the supine position. Upright measurements using a magnetic compass-oriented goniometric device consistently demonstrated measurement values substantially less than supine measurements obtained using a gravity-dependent goniometric device. The lack of agreement for upright and supine measures of active cervical rotation strongly suggests that researchers as well as practitioners in clinical practice had best clearly identify and document the position in which cervical rotation measurements were obtained. For cervical active ROM assessment to be interpretable, measurements must be performed in a consistent manner and potential differences in measurement methodology must be clearly identified, documented, and considered. Failure to document position of examination could potentially compromise reliability and result in misleading clinical data that could impact interpretation of a patient's treatment progress as well as assignment of disability ratings.

Conflicts of Interest

The authors have no conflicts of interest to declare.

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2015—COMING

Abstracts & Literature Review

Agreement of Upright and Supine Measurements of Active Cervical Rotation

Robert Cooperstein, MA, DC, Tammi Annette Clark, DC, Theresa Whitney, DC

Originally presented at the ACC-RAC conference, 2012

Clark T, Whitney T, Cooperstein R. (2012) Concurrent validity in range of motion measurement of seated versus supine active cervical rotation. *Journal of Chiropractic Education*;26(1):86.

JACO Editorial Reviewer: Gregory C. Priest, DC, FACO

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Authors' Abstract:

Background: Cervical active ROM measurements in flexion/extension and lateral flexion appear to be universally obtained with the subject in the upright position, regardless of the measurement device being utilized. However, measurement of cervical active rotation has been measured in either the upright or supine positions, depending on the technological capabilities of the measuring device being utilized. Supine and upright measures of active cervical range of motion may not provide interchangeable results. The goal of this study was to compare such measurements using devices commonly used in clinical practice.

Methods: Active cervical rotation of 32 participants was measured in the upright and supine positions. A series of 3 upright measurements were obtained using a single magnetic compass-oriented goniometric device, and 3 supine measurements with a single gravity-dependent goniometer device.

Results: Intra-examiner, intra-instrument reliability ranged from ICC (2,1)=0.876 to 0.912, rated "almost perfect." The mean inter-examiner, inter-instrument reliability for left rotation was ICC (2,2) = 0.255 ("poor"); and for right rotation ICC (2,2) = 0.492 ("moderate"). Supine measurements were consistently greater than upright measurements, by an average of 24.4° in left rotation and 15.0° in right rotation. A paired samples-t test revealed a statistically

significant difference between supine and upright measures.

Conclusions: Upright measurement of active cervical rotation does not provide information interchangeable with supine measures. Since the assessment of sagittal and frontal plane cervical movements is routinely done in the upright position, where functional disability is most likely to manifest, it stands to reason that transverse plane cervical movements (rotation) might best also be assessed in the upright position. This would most likely lead to a more accurate functional diagnosis. To ensure consistency of interpretation of active cervical rotation in research and clinical settings, it is important to consider the position in which active cervical rotation is measured. The position used may furthermore impact upon impairment ratings.

Keywords: Active, Range of Motion, Cervical Vertebrae, Reproducibility of Results, Reliability, Spine

Background

The measurement of active range of motion of the cervical spine is a commonly-used diagnostic tool and can be readily performed in the clinical setting with simple instrumentation. The authors seek to compare the measurements of active cervical rotation obtained in the upright position with those obtained in the supine position.

Methods

The study cohort consisted of 32 adults (16 males and 16 females) ranging in age from 23 to 51 years of age, selected after meeting inclusion criteria of being either asymptomatic or having neck pain of ≤ 2 on a 0-10 scale on the day of investigation. The measurements were obtained by two examiners experienced in the use of goniometric devices. Measurements of participants' active cervical rotation were obtained in upright and supine positions.

Results

There was a statistically significant difference between measurements of active cervical rotation in the upright and supine positions. The supine measurements were found to be consistently greater than the upright measurements.

Clinical Relevance

Neck pain, especially of mechanical origin, is often position-dependent. Measurement of cervical rotation in the supine position was shown to be substantially greater than in the upright position. Based upon the findings of this study, the position in which cervical range of motion evaluation is performed should be taken into consideration relative to a functional diagnosis.

JACO Editorial Summary

- Active cervical range of motion testing is a common diagnostic tool in the clinical setting.
- Intra-examiner, intra-instrument reliability when measuring active cervical rotation was “almost perfect”.
- Inter-examiner, inter-instrument reliability was poor for left rotation and moderate for right rotation.
- Active cervical rotation measurements were substantially greater in the supine position than in the upright position.
- From a functional disability standpoint, measurement of active cervical rotation in the upright position may lead to a more accurate functional diagnosis.



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Dysfunctional Endogenous Analgesia During Exercise in Patients with Chronic Pain: To Exercise or Not to Exercise?

Jo Nijs, Eva Kosek, Jessica Van Oosterwijck, Mira Meeus

Pain Physician 2012; 15:ES205-ES213 • ISSN 2150-1149
JACO Editorial Reviewer: Jaroslaw P. Grod, D.C., FCCS(C)

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Authors' Abstract:

Background: Exercise is an effective treatment for various chronic pain disorders, including fibromyalgia, chronic neck pain, osteoarthritis, rheumatoid arthritis, and chronic low back pain. Although the clinical benefits of exercise therapy in these populations are well established (i.e. evidence based), it is currently unclear whether exercise has positive effects on the processes involved in chronic pain (e.g. central pain modulation).

Objectives: Reviewing the available evidence addressing the effects of exercise on central pain modulation in patients with chronic pain.

Methods: Narrative review.

Results: Exercise activates endogenous analgesia in healthy individuals. The increased pain threshold following exercise is due to the release of endogenous opioids and activation of (supra) spinal nociceptive inhibitory mechanisms orchestrated by the brain. Exercise triggers the release of β -endorphins from the pituitary (peripherally) and the hypothalamus (centrally), which in turn enables analgesic effects by activating μ -opioid receptors peripherally and centrally, respectively. The hypothalamus, through its projections on the periaqueductal grey, has the capacity to activate descending nociceptive inhibitory mechanisms. However, several groups have shown dysfunctioning of endogenous analgesia in response to exercise in patients with chronic pain. Muscle contractions activate generalized endogenous analgesia in healthy, pain-free humans and patients with either osteoarthritis or rheumatoid arthritis,

but result in increased generalised pain sensitivity in fibromyalgia patients. In patients having local muscular pain (e.g. shoulder myalgia), exercising non-painful muscles activates generalized endogenous analgesia. However, exercising painful muscles does not change pain sensitivity either in the exercising muscle or at distant locations.

Limitations: The reviewed studies examined acute effects of exercise rather than long-term effects of exercise therapy.

Conclusions: A dysfunctional response of patients with chronic pain and aberrations in central pain modulation to exercise has been shown, indicating that exercise therapy should be individually tailored with emphasis on prevention of symptom flares. The paper discusses the translation of these findings to rehabilitation practice together with future research avenues.

Keywords: Whiplash, fibromyalgia, chronic pain, low back pain, exercise, rehabilitation, chronic fatigue syndrome, osteoarthritis, rheumatoid arthritis, sensitization, shoulder

JACO Editorial Summary

- This article was written by authors from the following institutions:
 - Fatigue Research Group (CHROPIVER), Department of Human Physiology, Faculty of

Physical Education & Physiotherapy, Vrije Universiteit, Brussel, Brussels, Belgium.

- Chronic Pain and Chronic Fatigue Research Group (CHROPIVER), Division of Musculoskeletal Physiotherapy, Department of Health Care Sciences, Artesis University College, Antwerp, Belgium.
 - Department of Physical Medicine and Physiotherapy, University Hospital, Brussels, Belgium.
 - Osher Center for Integrative Medicine, Stockholm, Sweden.
 - Brain Institute, Department of Clinical Neuroscience, Karolinska Institutet, Stockholm, Sweden.
- These are prestigious universities and faculties/programs in Europe.
 - Chronic pain befuddles and confuses both clinicians and scientists.
 - The majority of cases of chronic pain can be explained by alterations in central nervous system processing of incoming messages.
 - The authors emphasize that a different “*pain signature*” arises in the brain of those with chronic pain. This altered pain neuromatrix is comprised of: a) increased activity in brain areas known to be involved in acute pain sensations like the insula, anterior cingulate cortex, and the prefrontal cortex, but not in the primary or secondary somatosensory cortex (7); and b) brain activity in regions generally not involved in acute

pain sensations like various brain stem nuclei, dorsolateral frontal cortex, and parietal associated cortex (7).

- This paper explains our current understanding of the biology of endogenous analgesia (EA) following exercise in humans.
- This was meant to be a randomized and placebo-controlled cross-over study where the authors modulated endogenous opioid and serotonergic pain-inhibitory mechanisms during exercise by using selective serotonin reuptake inhibitor (SSRI; 2 mL of citalopram intravenously) during the DNIC and temporal summation model in response to exercise. SSRIs activate serotonergic descending pathways that recruit, in part, opioid peptide-containing interneurons of the dorsal horn (60). Unfortunately, significant side effects immediately after intravenous administration of citalopram resulted in early cessation of the study. Hence, currently no conclusions can be made addressing the role of serotonergic descending pathways in EA in response to exercise in chronic pain patients (59).
- *Exercise activates EA in healthy individuals, resulting in generalized increased pain tolerance during and immediately following exercise. This conclusion accounts for aerobic*

exercises like cycling, and for exercising local muscle groups.

- *In shoulder myalgia, exercising non-painful muscles activates generalized EA, but exercising painful muscles does not activate EA.*

Summary and Main Message

A dysfunctional response of patients with chronic pain and aberrations in central pain modulation to exercise has been shown, indicating that exercise therapy should be individually tailored with emphasis on prevention of symptom flares.

What is very valuable in this paper is **Table 1. Practical guidelines to account for dysfunctional endogenous analgesia during exercise when applying exercise therapy in patients with chronic musculoskeletal pain.** Here are five of twelve examples from this table:

- Exercise should be fun, not a burden
- Discuss the content of the exercise protocol with the patient; it should fit the needs and requests of the patient
- Use aerobic exercise as well as motor control training
- Be careful with eccentric exercise
- Include exercise of non-painful parts of the body

Effects of exercise on depressive symptoms in adults with arthritis and other rheumatic disease: a systematic review of meta-analyses.

George A Kelley, Kristi S Kelley

BMJ 2012;344:e2511 doi: 10.1136/bmj.e2511

JACO Editorial Reviewer: John M Ventura, DC, DABCO

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Author's Abstract:

Background: Depression is a major public health problem among adults with arthritis and other rheumatic disease. The purpose of this study was to conduct a systematic review of previous meta-analyses addressing the effects of exercise (aerobic, strength or both) on depressive symptoms in adults with osteoarthritis, rheumatoid arthritis, fibromyalgia and systemic lupus erythematosus.

Methods: Previous meta-analyses of randomized controlled trials were included by searching nine electronic databases and cross-referencing. Methodological quality was assessed using the Assessment of Multiple Systematic Reviews (AMSTAR) Instrument. Random-effects models that included the standardized mean difference (SMD) and 95% confidence intervals (CIs) were reported. The alpha value for statistical significance was set at $p \leq 0.05$. The U3

index, number needed to treat (NNT) and number of US people who could benefit were also calculated.

Results: Of the 95 citations initially identified, two aggregate data meta-analyses representing 6 and 19 effect sizes in as many as 870 fibromyalgia participants were included. Methodological quality was 91% and 82%, respectively. Exercise minus control group reductions in depressive symptoms were found for both meta-analyses (SMD, -0.61 , 95% CI, -0.99 to -0.23 , $p = 0.002$; SMD, -0.32 , 95% CI, -0.53 to -0.12 , $p = 0.002$). Percentile improvements (U3) were equivalent to 22.9 and 12.6. The number needed to treat was 6 and 9 with an estimated 0.83 and 0.56 million US people with fibromyalgia potentially benefitting.

Conclusions: Exercise improves depressive symptoms in adults with fibromyalgia. However, a need exists for

additional meta-analytic work on this topic.

JACO Editorial Summary

- Definitions
 - Meta Analysis – a statistical analysis that combines and contrasts the results from multiple studies in hopes of identifying patterns among the results. Meta-analysis is a way to aggregate data from multiple studies to improve statistical power. Meta analysis can be influenced by the choices the author makes, such as how to search for studies, study selection criteria, incomplete data sets, data analysis and bias.
 - Systematic Review – a systematic review is a formal, structured review of the scientific literature on some particular research question. They can be both quantitative and qualitative reviews. Often a systematic review will include a statistical meta-analysis of the data from the included studies. Systematic reviews include assessment of bias in the studies and a summary of results and conclusions.
- The purpose of the study was to do a systematic review of published and unpublished (masters and doctoral theses) meta-analysis studies of the effect of exercise (strength, aerobic or both) on depression in patients with osteoarthritis, rheumatoid arthritis, fibromyalgia or systemic lupus erythematosus. No meta-analytic studies were found for patients with osteoarthritis, rheumatoid arthritis or systemic lupus erythematosus. Two meta-analytic studies were found for fibromyalgia.
- Multiple statistical strategies were utilized in reviewing the meta-analyses (standardized mean difference, statistical significance, number needed to treat-NNT, standardized assessment of the quality of the meta-analyses) and the conclusion was that exercise can reduce depression in patients diagnosed with fibromyalgia.
- While there were some limitations noted with the results (heterogeneity, under-powering of study data), the results do compare favorably (reduction in depression) with pharmacological management of depression in fibromyalgia patients. While effects noted with anti-depressant medications were more consistent than the exercise studies, the results were similar enough to favor exercise given the cost and side-effects of medications.
- The authors proposed several suggestions for future research into this topic
 - Review should include those studies not included in the

review and why they were not chosen

- Meta-analyses typically aggregate data from multiple studies while the ideal situation is to collect individual participant data within each study and use that
- Include adverse event and cost data
- Include dose response for effect of exercise on fibromyalgia and other arthritic conditions
- Include number needed to treat (NNT); in the current systematic review, the authors took data and calculated their own NNT
- Control for heterogeneity in future studies: study population characteristics such as age, gender; intervention characteristics;

outcome assessment methodologies

- While dose response was not investigated, the authors recommend following the advice of Skinner on exercise protocol for arthritis patients
 - Minimize increase in pain, fatigue, other symptoms
 - Begin at low level (probably do not advance beyond low to moderate intensity for both aerobic and strength training)
 - Allow flexibility based upon how participant feels each day
 - Promote long term adherence

Overall Summary

Low to moderate intensity aerobic and strength training exercise appears to be a reasonable approach to reduce depression in patients with fibromyalgia, comparable to anti-depressant medications.

Several submaximal exercise tests are reliable, valid and acceptable in people with chronic pain, fibromyalgia or chronic fatigue: a systematic review.

Julia Rater, Lerenz Radlinger, Cees Lucas

Journal of Physiotherapy. 2014;60: 144–150]

JACO Editorial Reviewer: Steven G. Yeomans, DC, FACO

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Authors' Abstract:

Question: Are submaximal and maximal exercise tests reliable, valid and acceptable in people with chronic pain, fibromyalgia and fatigue disorders?

Design: Systematic review of studies of the psychometric properties of exercise tests.

Participants: People older than 18 years with chronic pain, fibromyalgia and chronic fatigue disorders.

Intervention: Studies of the measurement properties of tests of physical capacity in people with chronic pain, fibromyalgia or chronic fatigue disorders were included.

Outcome measures: Studies were required to report: reliability coefficients (intraclass correlation coefficient, alpha reliability coefficient, limits of agreements and Bland-Altman plots); validity

coefficients (intraclass correlation coefficient, Spearman's correlation, Kendall T coefficient, Pearson's correlation); or dropout rates.

Results: Fourteen studies were eligible: none had low risk of bias, 10 had unclear risk of bias and four had high risk of bias. The included studies evaluated: Astrand test; modified Astrand test; Lean body mass-based Astrand test; submaximal bicycle ergometer test following another protocol other than Astrand test; 2-km walk test; 5-minute, 6-minute and 10-minute walk tests; shuttle walk test; and modified symptom-limited Bruce treadmill test. None of the studies assessed maximal exercise tests. Where they had been tested, reliability and validity were generally high. Dropout rates were generally acceptable. The 2-km walk test was not recommended in fibromyalgia.

Conclusion: Moderate evidence was found for reliability, validity and acceptability of submaximal exercise tests in

patients with chronic pain, fibromyalgia or chronic fatigue. There is no evidence about maximal exercise tests in patients with chronic pain, fibromyalgia and chronic fatigue.

Clinical Relevance

This study supports the use of submaximal exercise tests in a chronic pain patient population including fibromyalgia and chronic fatigue. This systematic review is important as maximal exercise tests in this large population are too rigorous for this population and a submaximal test option is the appropriate selection for patients with chronic pain so objective outcomes can be measured.

JACO Editorial Summary

- The article was written by authors from the Netherlands and Switzerland.
- The purpose of the study was to evaluate whether submaximal exercise test options available were reliable, valid, and acceptable for use in people with chronic pain, fibromyalgia, and fatigue disorders.
- The investigative researchers performed a systematic review of studies focusing on the psychometric properties of submaximal exercise tests in subjects 18 years or older with

chronic pain using multiple outcome measures approaches.

- Chronic pain is a functional disorder or an illness where there is no obvious pathology in an organ and there is presumed dysfunction of an organ or system. Chronic pain, fibromyalgia, and chronic fatigue disorders are diagnoses frequently categorized as functional disorders.
- There is overlap of symptoms in these conditions as 30-70% of patients with fibromyalgia meet the criteria for chronic fatigue making the diagnostic dilemma even more challenging as both lack an acceptable disease model that can explain the signs and symptoms in pathophysiological terms.
- The validity of self-reported assessment of pain and disability by chronic pain patients is controversial as several studies reported that the level of pain reported did not always match their self-report of physical disability.
- The ideal evaluation in chronic pain patients should rely on the combination of clinical assessment (impairment), behavioral observation of physical function, and self-reporting.

- There is limited evidence about submaximal exercise testing as the “gold standard” of aerobic capacity relies on maximal testing with calorimetry. This is strongly influenced by motivation, fear and pain which often invalidates the use of this approach in chronic pain populations.
- One study reported over 90% of the variance in performance in a chronic musculoskeletal disabled population was predicted by psychosocial factors (self-efficacy, perceived emotional and physical functioning, pain intensity, and pain cognition).
- Submaximal test development has increased in the last decade as an alternative to maximal exercise tests especially for chronic pain patient populations.
- Submaximal exercise testing tends to over or under estimate maximal oxygen consumption (VO₂max) in 15% of healthy subjects. Subjects with chronic pain because of pain, fatigue, and fear of symptom worsening were often unable to perform the Astrand bicycle test.
- Guidance for clinicians is needed due to the variety in attributes of the available instruments making it difficult in selecting the best approach.
- The search included an initial 3496 studies which reduced to 2637 after removal of duplicates, which then reduced to 74 and ended with 14 studies involving 1275 participants. Sample sizes ranged from 24 to 683 with a mean age of 45 years (range 34 to 82 years).
- Exercise tests chosen were assessed by one study each except for Astrand test (3 studies), 5-minute walk test (3 studies), and a submaximal bicycle ergometer test following a protocol other than the Astrand test (3 studies).
- The authors found *no studies* that investigated the use of maximal exercise tests in chronic pain population groups.
- The authors reported use of the Astrand test and other bicycle ergometry tests alone and in combination with different walk tests. Walk tests (5-minute, 6 minute, and 10 minute) were all reported as having good to excellent reliability. No specialized equipment is required and walk tests appear to be acceptable for chronic low back pain patients.
- Correlation between several walk tests and self-reported tools were discussed which showed: a fair relationship was found between the 6-minute

walk test and SF-36 Physical Function scale and the Fibromyalgia Impact Questionnaire physical function scale; a moderate-to-good relationship with the American Shoulder and Elbow Surgeons function scale: low to moderate concurrent validity was reported between performance-based tests and other quality of life scales.

- A stronger correlation was reported between performance-based measures and activity limitation measures compared to pain related tools.
- The shuttle walk test and modified symptom-limited Bruce treadmill test were reported as useful tests as well.
- The authors discussed reasons why a meta-analysis could not be performed due to the significant differences in study design, psychometric properties evaluated, and incomplete reporting of the data. The lack of blinding and lack of a “gold standard” also were discussed as limiting factors.
- Stop criteria were comparable and included heart rate too high or low, signs of serious cardiovascular or pulmonary difficulties, and chest pain. Only 1 study used fatigue as a stop criterion which could have led

to a higher dropout rate compared to the other studies.

- The gold standard of exercise testing is maximal calorimetry, with detailed assessment of lactate, VO₂max, blood pressure, and electrocardiographic data. Because these tests are not available in many outpatient clinical settings, the measurements of patient’s subjective perception with standardized assessment (such as rating of perceived exertion), monitoring heart rate, and performing submaximal exercise tests seems to be most practical in a typical clinical outpatient setting.
- All of the submaximal exercise tests reviewed were reported as useful, feasible, and applicable to the chronic pain population.
- At most, one 20-30 minute session was reported as necessary for a submaximal test, although a treadmill or a cycle ergometer were needed for some of the tests.

Summary

This literature review should raise the awareness that there is moderate evidence supporting the reliability, validity and acceptability of the submaximal exercise tests that were studied in this review for people suffering from chronic pain,

fibromyalgia, and chronic fatigue disorders. However, there is no evidence about maximal exercise tests in this population. Consideration of including submaximal

exercise testing in a clinical setting is supported by the findings reported in this article.

Radiology Corner

Case Presentation: 52 year old male with axial neck pain and headaches. No reported trauma.

Cliff Tao DC, DACBR

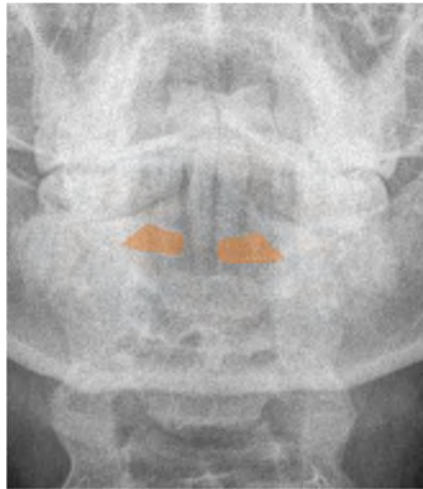
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What are the radiographic findings?

1. Mild C5/6 degenerative disc disease with small anterior and posterior spondylosis, compatible with disc herniation.
2. Incomplete midline posterior arch of C1, with resulting hypertrophic anterior arch.
3. Mild hypolordosis.

The disc disease and herniation may be the cause of the neck pain. There is absence of the spinolaminar line at C1, indicating a missing posterior tubercle – this is a subtle finding on the AP view (Fig 2). This anomaly of the atlas is an incidental finding and does not contribute to neck or headache

pain, and is not a contraindication to adjusting/manipulation. The large and sclerotic anterior arch may appear ominous, but this is probably a result of the posterior arch defect as these findings commonly occur in unison.

This example also highlights the necessity of obtaining APOM views for a more definitive frontal view of the upper cervical spine. The upper cervical spine is not well seen with overlying teeth and mandible.

As in most headache cases, there is no definitive causal radiographic finding, but the disc disease, herniation, and hypolordosis can certainly be contributing factors.

Announcements

Dr. Cox received honorary fellowship through the Academy

On October 11, 2014 the Academy of Chiropractic Orthopedists awarded the presentation of an Honorary Fellowship in the Academy to Dr. James Cox of Ft. Wayne, Indiana. Dr. Cox becomes the third non-orthopedic Diplomate to receive this honor.

Dr. Cox is being recognized for his tireless effort to bring forth referenced and germane information to the advanced learner. If you have heard him lecture, his educational material is closely aligned with the Stonebrink/2010 syllabus that is used for the teaching of the chiropractic orthopedic Diplomate.

Dr. Cox is a certified instructor through NHSU and his information and lecture material is PACE approved for advanced continuing education. He has lectured extensively to orthopedic groups. I recall one orthopedic symposium that he was to speak for 4 hours, but the lecture after him could not make the following speaking engagement. Dr. Cox was asked and accepted the additional hours and went on to lecture 4 more hours extemporaneously and cited literature without repeating himself. The specialty of chiropractic orthopedics is blessed to have a good friend in Dr. James Cox.