World Leader in Spinal Biomechanical Research Shows Clinicians the Applicability of Spinal Ligament Testing Results in Potential Work Modifications

By: Steven P. Brownstein, MD & Jeffrey A. Cronk, DC, CICE Director of Education Spinal Kinetics

Spine loading at different lumbar levels during pushing and pulling

Gregory G. Knapik and William S. Marras*
Biodynamics Laboratory, The Ohio State University, Columbus, Ohio, USA
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In this publication, Dr. William S. Marras perhaps the top published Applied Spinal Biomechanics Researcher in the world, shows us the applicability of the "Radiographic Intersegmental Motion Analysis" (RISMA) performed with weight bearing x-ray imaging and a "Computerized Radiographic Mensuration Analysis" (CRMA).

CRMA is a spinal ligament analysis performed on stress films, that helps the provider to understand the location and severity of interspinous ligamentous instability so often associated with both acute and cumulative trauma spinal soft tissue injuries. This information assists the clinician in determining the location and severity of the spinal sprain injury, allows them to clinically correlate spinal instabilities to more specific spinal levels, and allows them to rule in or rule out the AMA's "alteration of motion segment integrity" all in one study.

The AMA alteration of motion segment integrity mensuration criteria is considered to be a more severe sprain finding, and the finding comes with a significant level of impairment in the AMA Impairment Guides. This objective documentation is also utilized by Impairment and Disability Rating Providers so that they can more accurately place the patient at the proper level using the proper objective criteria already established and cited in today's Impairment and Disability Guidelines.

While this paper has the purpose of showing the reader the applicability of the results of this type of analysis in work modification, one cannot do so without touching on its ability to improve the objectivity of impairment and disability ratings.

"The U.S. Bureau of Disability Insurance (27) specifies that loss or limitation evaluation be objective and "demonstrable by medically acceptable clinical and laboratory diagnostic techniques." (1)

All parties involved (patient, doctor, adjuster, legal representatives etc.) are demanding the need for better, more reliable objective information via demonstrable diagnostic techniques, which CRMA certainly supplies. CRMA has the ability to significantly reduce the subjectivity of both impairment and disability examinations as identified below.

"Quantification of low back impairment has traditionally been extremely difficult and elusive. Currently, impairment ratings of LBD vary by as much as 70% (28). As an example, Fig. 14.1 shows the disability ratings of the same patient by 65 independent medical examiners (IMEs). The figure shows that the range of disability varied from 0% to 70%. The problem with such subjective assessments that lack objective criteria is apparent from the lack of convergence of the assessments. It has been estimated that a precise diagnosis is unknown in 80-90% of disabling LBDs, emphasizing the need for more quantitative measures (29).

Traditionally, attempts to judge impairments have tried to identify anatomic sources of the low back pain. Imaging techniques such as CT scans, MRI, and myelograms are used to assist in the *identification of the structure that has been compromised. However, over 85% of LBDs do not have a pathoanatomic diagnosis (25). This finding is not surprising since few current imaging techniques are able to observe anatomic anomalies while subjects are positioned in a functionally painful posture. For example, most high quality imaging such as MRI is performed while the patient is lying supine on a table. When lying supine, the vertebrae experience minimal spine force and any damaged disc will not have enough force imposed on them to divulge a bulging disc on an image if it were present in more natural work postures (e.g., standing or bent over). Hence, most traditional imaging is of minimal benefit for identifying spine mechanical problems due to mismatch of spine loading with spine tolerance."(2)*

CRMA has the ability to significantly enhance the most common and cost effective clinical weight bearing imaging procedure, which is standard radiographic stress imaging (flexion, extension studies).

Again the focus of this paper is to show the practical utilization of a CRMA for work modification instruction. Dr Marras's work above is a key link to this application, and I will now spend the rest of this paper showing the reader how.

If the reader is not familiar the Radiographic Intersegmental Motion Analysis (RISMA), it is an analysis that measures the vertebral relationships in a weight bearing environment, as captured with stress x-rays and the use of the CRMA. Very simply, the spinal ligaments are passive restraints that hold the vertebral bodies in alignment while under load. When these ligaments are damaged they allow for abnormal motion patterns of the individual vertebra to occur. The CRMA process is validated by peer reviewed research to be the most accurate and reliable way to accomplish a Radiographic Intersegmental Motion Analysis.

"This study suggests that commonly used methods to assess flexion-extension X-rays of the cervical spine may not provide reliable clinical information about intervertebral motion abnormalities, and that validated, computer-assisted methods can dramatically improve agreement among clinicians. (3)

To the reader who is interested in improving our current understanding of "pathoanatomic" diagnosis, it goes without saying computer assistance can achieve improved reliability and accuracy of such Intersegmental measurements, especially when one considers that this previously has been subjectively produced at best, when produced at all. In other words the professional simply tries to "eyeball the results" rather that utilize a more standard and sophisticated means to actually measure it.

Now for the application of the results in potential work modification that would be employed by the knowledgeable provider.

In the initial research cited above, Marras shows us the following:

"As the risk of low back pain associated with lifting and carrying has been recognized, many occupational tasks have been converted into pushing or pulling activities and, thus, increasingly expose workers to horizontal applications of force. In addition, as the nature of work changes, pushing and pulling has become more common. Manufacturing globalization has increased the handling of products prior to distribution. Many products are stored, at least temporarily, in distribution centers, where large amounts of pushing and pulling are common.

Several sources report that as much as 20% of low back injury claims are associated with pushing and pulling (National Institute for Occupational Safety and Health 1981, Hoozemans et al. 1998). A review of low back pain Bureau of Workers' Compensation Claims in Ohio indicates that 27% of claims were related to pushing and pulling activities. Exposure to pushing and pulling activities is increasing in the workplace, yet there is poor understanding of how pushing and pulling may impact biomechanical loading and the subsequent risk of low back pain.

However, this study provides some insight as to how much load is too much from a pushing and pulling perspective.

Figure 3 indicates that pushing or pulling loads equivalent to 40% of body weight are problematic, as are pushing loads equivalent to 30% of body weight. Pulling loads equivalent of 30% of body weight appear to be at the margin of safe activities and pushing and pulling loads of 20% of body weight would not be expected to be problematic.

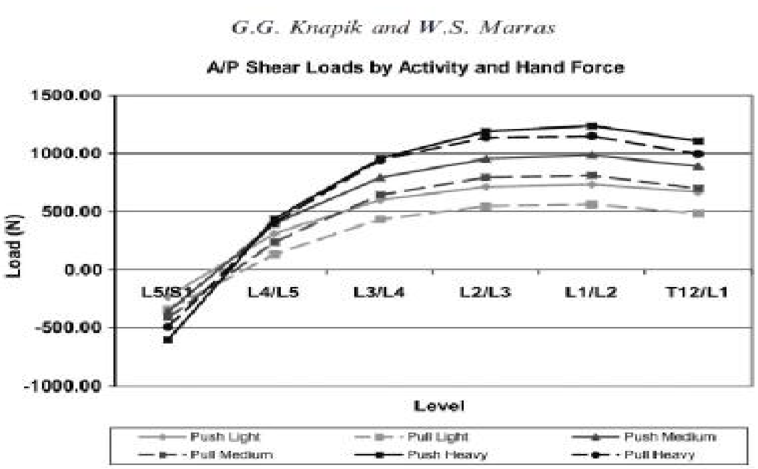
Thus, these analyses provide some preliminary biomechanically based limits for occupational tasks. " (4)

Marras, using state of the art equipment, had volunteers push and pull from their waist, mid stomach area and then straight out from the upper chest area. This equipment was capable of measuring both the compressive and spinal shear forces of the activity at each specific lumbar level. This type of information has significant use in clinical application.

Very simply stated, Marras and associates showed with incredible precision that when a person is involved in a job where they are pushing and pulling materials that weigh 30%-40% of the person's body weight it can provide risk to the worker because the amount of force exerted intersegmentally as a shear force can exceed the recognized ligamentous tolerance for that person, leading of course to a ligamentous injury called a spinal ligamentous sprain.

So if a 180lb person is pushing or pulling objects at 54 lbs or greater they are at risk. If a 120 lb female is pushing or pulling 36lbs they can be at risk etc. The reader can do the math and it is really quite simple.

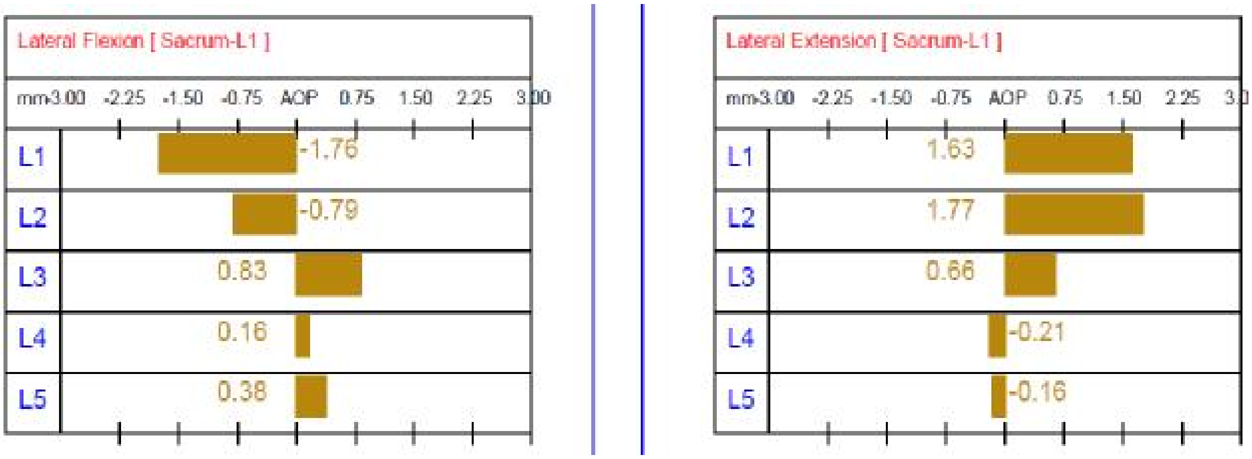
In the first image below, Marras shows us the most import aspect for clinical application, which what vertebral levels experience the highest levels of shear force.



The 1000 Newton limit is the commonly cited limit for shear force, above which can cause ligamentous injury. McGill is commonly cited and the research responsible for setting the 1000 N Threshold for ligamentous injury.

To make this practical the L1-L3 Vertebra are at risk here in this activity. The patient either comes in for a low back assessment due to a work related trauma, or is a patient who sustained a back injury through another mechanism of injury such a “rear end” auto collision so common in spinal trauma work today. Either way the patient works in a job where this level of pushing or pulling activity is present.

In the evaluation, the patient undergoes stress (lumbar flexion, extension) views and the images are sent out for a CRMA to determine the ligament status of the intersegmental levels. This is part of their report findings:



The clinician among many other things is apprized that there is significant abnormal motion patterns at the L1-L2 vertebral level.

This patient is showing significant ligament impairment and the exact levels that can be seriously overstressed on their job. So regardless of the “mechanism of injury” i.e., work related, auto accident, spots injury etc., they may need work modification and their place of work. They may need other modifications to their activities of daily living as well.

This patient shows ligament impairment at the levels that are under the most stress in their work environment, which of course would significantly increase their risk of further injury and retard their recovery and even potentially make recovery impossible. In the initial phase of their recovery, when the injury can be highly unstable as it has not had time to adequately heal, they may need to take some time off of that particular activity. They may need to perform other duties for their employer in order to remove the risk of consecutive exacerbations.

One has to realize that damage to the spinal ligaments damages the imbedded mechanoreceptors, thus causing the reduction of neuromuscular control in that area and further destabilizing the area. Disturbed intersegmental motor control can cause further abnormal loading of the ligaments resulting in further ligamentous sub-failure and further, a now progressive instability that can result in a permanent painful back condition that is now chronic leading to a higher rate of actual impairment and disability.

To the educated providers who specializes in these types of injuries the application of the CRMA results for work or activity modification are obvious. To the uneducated or inexperienced provider this paper is an attempt to further educate you on the applicability of a CRMA report for activity modification.

Radiographic Intersegmental Spinal Motion Analysis (RISMA) via CRMA is a test that can unify and align all spinal care providers in their respective sub-specialties, as the results can help to drive all patients care decisions, activity modification instructions etc., for better results!

This one objective test just has too many applications to be educated on in one paper. This was an attempt to show one very specific application; work or activity modification.

References:

1. William S. Marras. The Working Back: A Systems View (p. 255). Kindle Edition.
2. William S. Marras. The Working Back: A Systems View (p. 255). Kindle Edition.
3. Observer agreement in assessing flexion-extension X-rays of the cervical spine, with and without the use of quantitative measurements of intervertebral motion Taylor et al Spine 2007
4. Spine loading at different lumbar levels during pushing and pulling. Gregory G. Knapik and William S. Marras* Biodynamics Laboratory, The Ohio State University, Columbus, Ohio, USA Ergonomics Vol. 52, No. 1, January 2009, 60–70

SPINAL KINETICS
The Measurable Difference

950 West Chestnut St.
Union, NJ 07083
877-508-9729 fax-908-933-0379

800 Wisconsin St.
Bldg. D2 S-102 Mail Box 50
Eau Claire, WI 54703
715-833-8533 fax-715-839-7902

e-mail: spinalkineticsllc@yahoo.com
web: www.spinal-kinetics.com