NIOSH (National Institute for Occupational Safety and Health) Low Back Atlas of Standardized Test/Measures

(U.S.) National Inst. for Occupational Safety and Health, Morgantown, WV

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NIOSH LOW BACK ATLAS OF STANDARDIZED TESTS/MEASURES

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Centers for Disease Control
National Institute for Occupational Safety and Health
Division of Safety Research
Morgantown, West Virginia 26505

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PREAMBLE

The NIOSH Low Back Atlas (LBA) has been developed to provide a standardized list of tests/measures for use by health care practitioners in the medical and the industrial communities when assessing low back musculoskeletal injuries. The LBA is a list of tests/measures which may be used to collect subjective and objective data about the symptoms and signs of spinal movement dysfunction. The LBA breaks new ground. It is an ambitious research project dealing with an area of low back research that has not been comprehensively examined by strict scientific methods in recent years. This five year project of clinical evaluation and statistical analysis has produced an atlas of tests/measures which serves as a foundation and starting point for a larger, comprehensive Low Back Evaluation (LBE) System. The future development of the LBE System for assessing low back musculoskeletal injuries in the workplace depends upon validation, as well as, the development of a classification and/or categorization system. Both research efforts are in the planning stage.

The Low Back Atlas, contained in this document, consists of two parts: The first (Part 1) is an instructional manual for standardized tests/measures, the second (Part 2) is the format for recording the data from the tests/measures administered. The tests/measures included in this atlas have been rigorously studied in a clinical setting using strict scientific techniques. There are 24 tests/measures reported in this publication. Acceptable levels of reliability were found in 19 of the tests/measures, while marginal reliability were found in the remaining five. A summary of statistical results appears before the test/measure description. Other tests/measures not included in this document have been examined but found to have low levels of reliability or insufficient distribution of subjects upon which to make an adequate decision (Appendix D). The description of this second set of tests/measures along with accompanying statistical results may be found in National Technical Information Service (NTIS) publications.

Several delimiting factors concerning the development of the Low Back Atlas must be noted in order to understand the scope and appropriate application of this atlas to the occupational and clinical setting:

- The use of the Low Back Atlas of standardized tests/measures allows for the collection of subjective and objective data about the symptoms and signs of spinal movement dysfunction low back musculoskeletal injury problem. The tests/measures reported in this document do not clinically manage the individual from the time of injury to the definition of the problem. For example, this document does not contain medical decision guides to aid the health practitioner in classifying a low back musculoskeletal injury into a medical, discal, internal derangement, traumatic, etc. category. The health care practitioner must first make the decision that the problem is a low back musculoskeletal injury. When that initial decision is made, the standardized list of tests/measures contained in the Low Back Atlas may be used in conjunction with a diagnostic or classification scheme to arrive at an understanding of the low back musculoskeletal problem.

- The tests/measures reported in this Low Back Atlas have reliability coefficients of at least .75 for Cohen's Kappa and .80 coefficients for Interclass Correlation (ICC). A complete description of the experimental and statistical methods as well as the results utilized in the clinical study may be found in NTIS publications.

- The tests/measures reported in this document were found to be reliable for three "expert" examiners.

In addition, the results suggest that three "novice" examiners were able to be trained in the procedures used and were able to administer the standardized list of tests/measures within the confines of the current experiment. It is suggested that each facility determine their own levels of reliability for their examiners using the same instructional procedures noted in Part 1 of this standardized atlas of tests/measures.

- The tests/measures reported in this document have been carefully ordered so that one test does not react to, or adversely affect other tests/measures in the sequence. The examiner using this protocol should consider performing these tests/measures in the order provided. Reordering the test sequence or using only selected tests (out of original order) from the Low Back Atlas may adversely affect the outcome measures of the respective tests.

- The tests/measures reported in this document have not been examined for concurrent validity. Refinement of the clinical validity for the Low Back Atlas tests/measures remain as a scientific task in future research efforts.

- The tests/measures reported in this document serve as a starting point for future research. If the standardized clinical assessment procedure and the reporting format are used as presented in this document, the results obtained should be repeatable across examiners.

- The tests/measures reported in this document do not address the issues of risk factor analysis, intervention strategies or prevention programs. Further research is needed to evaluate and develop each of these areas.

- The standardized list of tests/measures contained in the Low Back Atlas may be used in conjunction with a diagnostic or classification scheme to arrive at an understanding of the low back musculoskeletal problem.

Summary

The Low Back Atlas advances the "state of the art" in low back research by providing a standardized, reliable list of tests/measures which may be used by researchers and clinicians to conduct scientific and clinical studies related to low back musculoskeletal injuries. The Low Back Atlas presents a list of standardized tests/measures that may be utilized during the assessment of a musculoskeletal injury to the low back. A common language to facilitate an effective exchange of research information is provided by the Low Back Atlas.

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ACKNOWLEDGEMENTS

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INTRODUCTION

In February 1984, the National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), initiated a research effort to standardize a list of tests/measures which may be used to assess musculoskeletal injuries to the low back. The goal of this NIOSH research project was to provide a reliable, standardized clinical assessment tool for use by the medical and industrial communities in evaluating low back musculoskeletal injuries. In order to accomplish this goal, an expert panel of clinicians, researchers and educators was brought together at NIOSH/DSR, Morgantown, West Virginia, from February 28 to March 1, 1984. During this meeting a decision was made to concentrate on the largest category of low back injuries known as Low Back Strains/Sprains (LBS/S). Since the medical model of disease classification does not adequately describe the LBS/S category a conscious decision was made by the panel to attempt a description of LBS/S by a schema according to the patients presenting symptoms and signs.

The following are the performance criteria developed for use as a guideline in evaluating and providing a functional description of spinal dysfunction based on symptoms and signs:

- The examination process should be developed for individuals who have sustained an initial low back musculoskeletal injury (no previous episode of low back dysfunction within the last year).
- The examination process must be applicable to all clinical situations.
- The tests and measurements decided upon as part of the examination process must be reliable.
- The examination process must be performed in an objective manner regardless of prior knowledge or bias relating to diagnostic categories.
- The examiner must be specifically trained to have a minimally acceptable level of competence in performance and interpretation of the examination process.
- The examination process must be easily administered with minimal time expended for both the patient and the examiner.
- The results of the examination process should lead to a functional description of spinal dysfunction based on symptoms and signs.
- The record of results of the examination process should be computer compatible.

Using the performance criteria as a guide, the panel began to assemble a list of tests/measures which had the potential to classify patients according to symptoms and signs. A total of 105 tests/measures were identified (Appendix A) that were felt to constitute the "universe" of measurements used during a clinical evaluation of a low back injury. It was not implied that every patient would be subjected to all 105 test procedures, simply that the collated material represented the spectrum of possible tests/measures. The issue of reliability was raised for each enumerated test/measure. In the majority of cases, the specific reliability was an unknown factor. In addition, there appeared to be no standard agreed upon by which the test/measure could be administered and patient response variables recorded. A first attempt was made to standardize each test/measure through written text and accompanying illustration. Each test was depicted in a manual by a

photograph of the procedure accompanied by a written description of the clinical procedure along with the accompanying outcome measures.

A peer review meeting was held at NIOSH on September 20, 1984 to discuss the collated list 105 of tests/measures (Appendix A). The peer review panel discussed the test manual and recommended that each test/measure be described in a format that eliminated current ambiguity. For example, the anthropometric description of bone landmarks and anatomic sites must be described as they appear in commonly accepted published material. In addition, the test procedure must contain clear and unambiguous language so as to make the test maneuver procedure abundantly clear. The devices used to obtain the measurements must be accurate and reliable to ensure ease of operation and reproducibility of results. The use of objective biomechanical standards to measure outcome must be included in the description for each procedure. Twenty (20) tests/measures could not meet this initial criteria even with suggested changes in procedures and were subsequently eliminated from the original list of 105 tests/measures. The peer review panel also recommended that the remaining 85 tests/measures be studied under clinical experimental settings using strict scientific techniques.

The process of developing one controlled clinical study which evaluated all 85 tests/measures was beyond the scope of one institution along broad areas of interest and functional categories. It was decided to break up the task into 5 separate groups. The advantage of such a division of
labor was both rapid turn around time and broad based research support.

The five major areas were: Subjective (e.g. History), Neurologic, Kinesiologic, Muscle Strength/Length and Movement Testing (Appendix B). Each major area had an average of 16 tests/measures which was assigned to a research site at a major university or clinical center. (This portion of the study will be referred to as the "five site study" in later portions of this report.) The research sites were: The George Washington University, Hayward Orthopedic Center, The University of Iowa, Washington University, and West Virginia University. A strict experimental guideline for each test/measure was developed by each site and made consistent across sites.

The research subjects were carefully selected by common criteria, to represent those individuals sustaining an initial low back injury. Experimental quality and consistency was maintained through the use of an outside group of experimental control advisors. Constant review and control of each clinical experimental project was completed through a review and comment by the experimental control advisors and the NIOSH project officer.

This data collection phase was multi-institutional and involved more than 250 low back musculoskeletal injured patients and 15 examiners. In each test/measure an average of nine sub-items were measured, recorded, and subsequently analyzed. These sub-items included information on low back range of motion, muscle strength/length, changes in symptoms and signs in response to single, repeated and sustained movements, alterations in pain/paresthesia patterns before, during and after testing procedures, etc. Data analysis was complicated and produced in excess of 12,000 individual statistical analyses. Depending on the scaling type of data collected, a Cohen's Kappa Coefficient or an Intraclass Correlation Coefficient (ICC) statistic was used for data analysis.

The eighty-five tests/measures were each evaluated according to their resultant statistic. A cutoff of .75 for a Cohen's Kappa and/or a .80 for an ICC was used to assign the test/measure in the "acceptable" category. Those tests/measures with Kappa's and ICC's that did not reach the acceptable cut-off but were deemed both useful by the clinical experts and felt to have potential for improvement were assigned to the "marginal" category. Those tests/measures which had Kappa's and/or ICC's below .40 and did not meet the "marginal" criteria were assigned to the "low" category. Some tests/measures could not be tested because they had too few subjects in that category or the distribution of subjects was not sufficient in that category for analysis.

These tests/measures were put in a "insufficient distribution" category.

A finalized list of 68 "acceptable"/"marginal" tests/measures was assembled (Appendix C). These 68 tests/measures were subjected to an additional series of controlled experiments designed to specifically review each test/measure and so that it could be restructured. The knowledge gained from the previous experiment (five site study) helped the refinement of each test/measure for the 68 test/measure clinical trial study (Washington University).

Each test/measure was standardized according to: test description, test instruments required, definition of terms, contraindications, starting position of patient, starting position of examiner, procedure, order of assessments, timing, rest periods, what to do if the patient cannot attain or maintain position, indications to discontinue the test, position in which to leave the patient, and common errors to avoid. Since the reliability estimates would be carried out in a clinical setting with low back injured patients, the rest periods and test/measure ordering was of prime importance. The ordering went through many iterations before the final list was established.

The clinical trial based study was conducted using a total of 53 subjects (Washington University). The analysis for each statistic, depending on the scaling type of data, was the same as the "five site study" enumerated earlier in this report.

Upon completion of the clinical trial study, a meeting with the contractors and clinical experts was held at NIOSH from May 11 to 13, 1987. The tests/measures were again classified into one of four categories: acceptable, marginal, low, and insufficient distribution. The tests/measures which were not included due to low reliability or insufficient distribution may be found in Appendix D.

The following document presents the NIOSH Low Back Atlas (LBA) of nineteen standardized tests/measures which had acceptable levels of reliability. The enclosed LBA is divided into two parts.

Part 1. Description of tests/measures

Part 2. Recording Form

Part 1: Contains a verbal description of each test/measure. In current form, pictures or video descriptions are not ready. A training manual utilizing a pictorial, action video and training module is in the planning stages.

Each test/measure in Part 1 is standardized according to: test description, test instrument required, definition of terms, contraindications, starting position of patient, starting position of examiner, procedure, order of assessments, timing, rest periods, what to do if the patient cannot attain or maintain position, indications to discontinue the test, position in which to leave the patient, and common errors to avoid.

Part 2: The LBA recording form has been carefully developed to obtain reproducible results. The various grids and marking areas are important and should be followed.

Summary

The 19 tests/measures presented in this document comprise the NIOSH Low Back Atlas. The LBA is a standardized list of tests/measures that has a known reliability. This atlas may be used to collect subjective and objective data concerning the symptoms and signs of spinal movement dysfunction. Validity of the tests/measures along with a classification schema remain to be determined by future research. In the current format, the LBA provides a reliable list of tests/measures which may be used to collect subjective and objective data

about the symptoms and signs of spinal movement dysfunction resulting from a musculoskeletal injury to the low back. This research effort is the first multi-institutional research effort to obtain a broad consensus of procedures to assess musculoskeletal injuries to the low back.

PART 1 - TEST/MEASURE DESCRIPTION

[Note: Marginal tests are so noted]

19 ACCEPTABLE TESTS

TEST	REASON FOR ACCEPTING
STANDING	
Lumbar lordosis-flexible ruler-standing	F=3.24
Iliac crest-posterior-standing*	All tests (*) lead to acceptable assessment of rotated inominate and asymmetry of leg length
PSIS-posterior-standing*	
Iliac crest-anterior-standing*	
ASIS-anterior-standing*	
Side bending	
right	start K=.98 finish K=.95 excursion F=4.21
left	start F=11.4 finish F=8.97 excursion F=6.29
SITTING	
Iliac crest-anterior and posterior-sitting*	
PSIS -posterior-sitting*	
Lumbar lordosis-flexible ruler-relaxed sitting	F=5.48
Lumbar lordosis-flexible ruler-sustained erect sitting	F=3.37
Lumbar lordosis-flexible ruler-sustained slouched sitting	F=4.71

19 ACCEPTABLE TESTS

(Continued)

TEST	REASON FOR ACCEPTING
PRONE	
Hip joint rotation range of motion	
internal rotation	
right	F=11.8
left	F=12.6
external rotation	
right	F=2.27
left	226
Sustained extension in prone lying-press up - symptom change	K1-3=.77, K1-2=.75
SUPINE	
Single straight leg raise	
right	F=3.85
left	F=5.43
Double straight leg raising	F=2.16
Hamstring length	
right	F=2.09
left	F=3.18

KEY:
K=Cohen's Kappa interreliability
F=F statistic value

K greater than .75 is considered acceptable
Kx= Kappa value between expert examiners

FIVE MARGINAL TESTS

TEST	MARGINAL VALUES
PRONE	
Hip flexor muscle strength	
right	K1-3=.45
left	KT5=.64
Lower abdominal muscle strength	K1-3=.47
Short hip extensor length	considered valuable by experts although not statistically marginal.
Hip flexor length	
presence of hip abduction	
right	Ktot=.44
left	Ktot=.48
N/A	Ktot=.44
right external rotation (tibia)	Ktot=.40
medial rotation (hip)	
right	Ktot=.4
left	Ktot=.41
lateral rotation (hip)	
right	Ktot=.55
left	Ktot=.46
Upper abdominal muscle strength	KT5=.52
SIDE-LYING	
Gluteus medius muscle strength	considered valuable by experts, although not statistically marginal.

KEY:
K:= Cohen's Kappa value between individual testers or
total (tot) K values between .40 and .74 are considered marginal.

The Tests

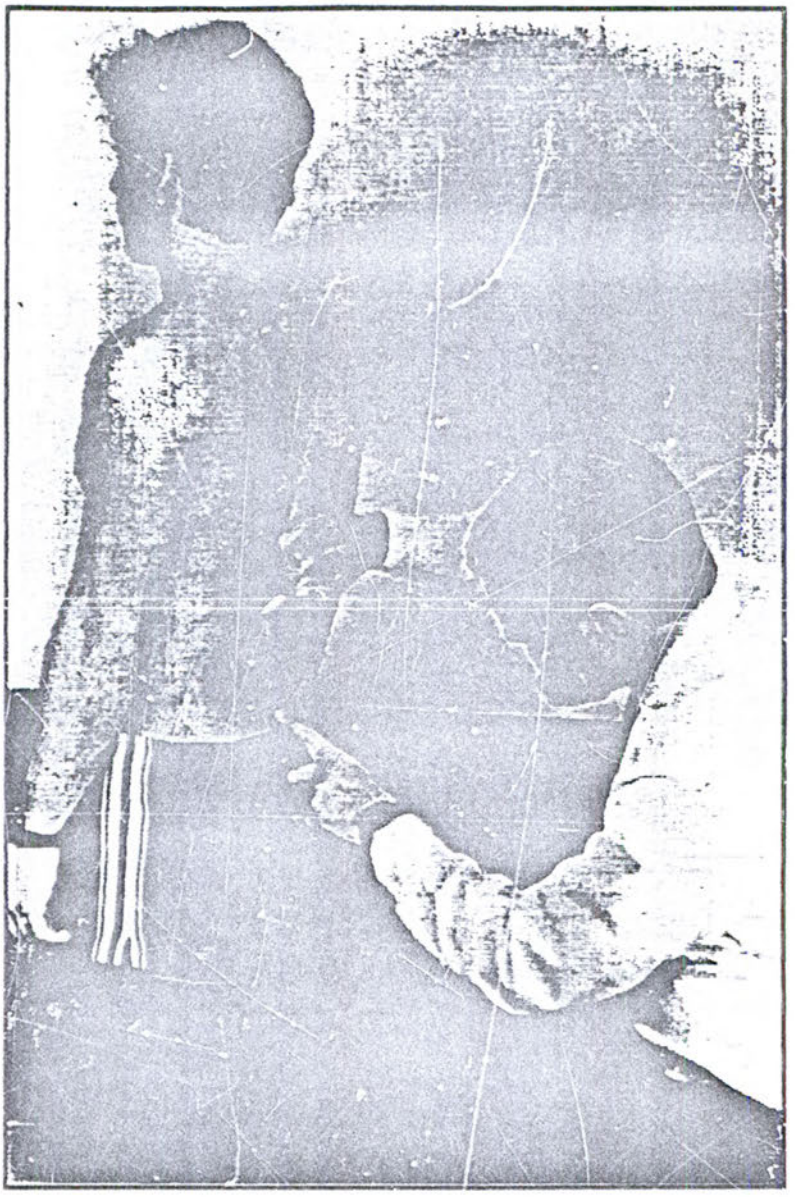

Figure 1. Lumbar Lordosis -- Flexible Ruler -- Standing

Lumbar Lordosis -- Flexible Ruler -- Standing

DESCRIPTION: Assessment of the lordotic shape of the lumbar spine in the sagittal plane by the use of a flexible ruler, with subject in a relaxed standing position. The ruler is made to conform to the subject's spine from the interspinous space between L5 and L1.

INSTRUMENTS REQUIRED: Flexible ruler and felt tip pen to mark anatomic structures.

DEFINITION OF TERMS: None.

CONTRAINDICATIONS: Subject cannot attain or maintain the static standing position for a short period or cannot tolerate the necessary pressure involved to conform the ruler to the lumbar spine.

STARTING POSITION OF SUBJECT: Assumes a comfortable standing position with arms at the sides, knees straight, and weight borne evenly on both feet.

STARTING POSITION OF EXAMINER: Seated on a stool in back of the subject.

PROCEDURE: The examiner places his or her thumbs beneath the anatomic area where the posterior superior iliac spines (PSISs) are located. The thumbs then are slid upward until they come into contact with the inferior slope of the PSISs, at which point the bones will stop further progression. The examiner draws an imaginary line between the two palpating thumbs. A marking dot is placed at the midpoint of that imaginary line. The palpating thumbs put pressure over the spinous process of L5 (marking dot at the midpoint) and subsequent spinous processes as the examiner sequentially palpates up the spine to T12. Another marking dot is placed in the interspinous space between T12 and L1. The flexible ruler is placed against the subject's back, with the top of the bottom tape lined up with the lower marking dot (L5). The flexible ruler is then conformed to the subject's lumbar spine, and a pencil mark is made on the ruler where it lines up with the superior marking dot (L1). The ruler is removed from the subject's back and placed on the Recording Form. A tracing is made of the ruler from the side that was touching the subject. The tracing should be from the bottom end of the ruler tape (L5) to the pencil mark (L1). The degree of lordosis is calculated (Attachment A). The degree angle is recorded on the Recording Form.

ORDER OF ASSESSMENTS: None.

TIMING: None.

REST PERIODS: None.

WHAT TO DO IF SUBJECT CANNOT ATTAIN OR MAINTAIN POSITION: Allow one minute of rest in the subject's most comfortable position. Try again; if that fails, abort the test, indicate N/A on the Recording Form, and explain the reason for the failure.

INDICATIONS TO DISCONTINUE TEST: Failure on second attempt.

POSITION IN WHICH TO LEAVE SUBJECT: In the subject's most comfortable standing position.

COMMON ERRORS TO AVOID: The examiner not having his or her dominant eye positioned at the same level as the thumbs and midway between the two thumbs, not having the thumbs bilaterally on the same contact areas, miscounting levels, not locating the junction of the sacrum and the lumbar spines, or failing to use enough pressure to conform the ruler to the bones over the interposing soft tissue.

Figure 2. Iliac Crest -- Posterior -- Standing

Iliac Crest -- Posterior -- Standing

DESCRIPTION: Assessment of the levels of the iliac crests by the use of a crest tester, with subject in an erect standing posture.

INSTRUMENTS REQUIRED: Crest tester.

DEFINITION OF TERMS: None.

CONTRAINDICATIONS: Subject cannot attain or maintain the static erect standing position for a short period.

STARTING POSITION OF SUBJECT: Assumes a comfortable standing position with knees straight and weight borne evenly on both feet.

STARTING POSITION OF EXAMINER: Seated on a stool in back of the subject.

PROCEDURE: The examiner spreads the bars of the crest tester. Each of the bars then are placed an equal distance from the midline of the tester. The examiner then places the crest tester opening so one bar is on the right side and the other is on the left side of the subject's trunk. The examiner slides the bars together so they are over the iliac crests and gently presses the bars down onto the iliac crests. The movement of the bars should be toward the midline, with care taken not to trap tissue superior to the iliac crests. The examiner observes the bubble level on the tester. The bubble will deviate toward the side of a high crest. The examiner makes a visual observation for bubble deviation and records results on the Recording Form that a crest is high on the right or on the left or that the crests are equal.

ORDER OF ASSESSMENTS: None.

TIMING: None.

REST PERIODS: None.

WHAT TO DO IF SUBJECT CANNOT ATTAIN OR MAINTAIN POSITION: Allow one minute of rest in the subject's most comfortable position. Try again; if that fails, abort the test, indicate N/A on the Recording Form, and explain the reason for the failure.

INDICATIONS TO DISCONTINUE TEST: Failure on second attempt.

POSITION IN WHICH TO LEAVE SUBJECT: In the subject's most comfortable standing position.

COMMON ERRORS TO AVOID: Not having the crest tester bars in symmetrical contact with the iliac crests, having the subject stand on a floor that is not level, or allowing other joints of subject to influence the measurement (ie, inadvertent flexion at one hip or knee).

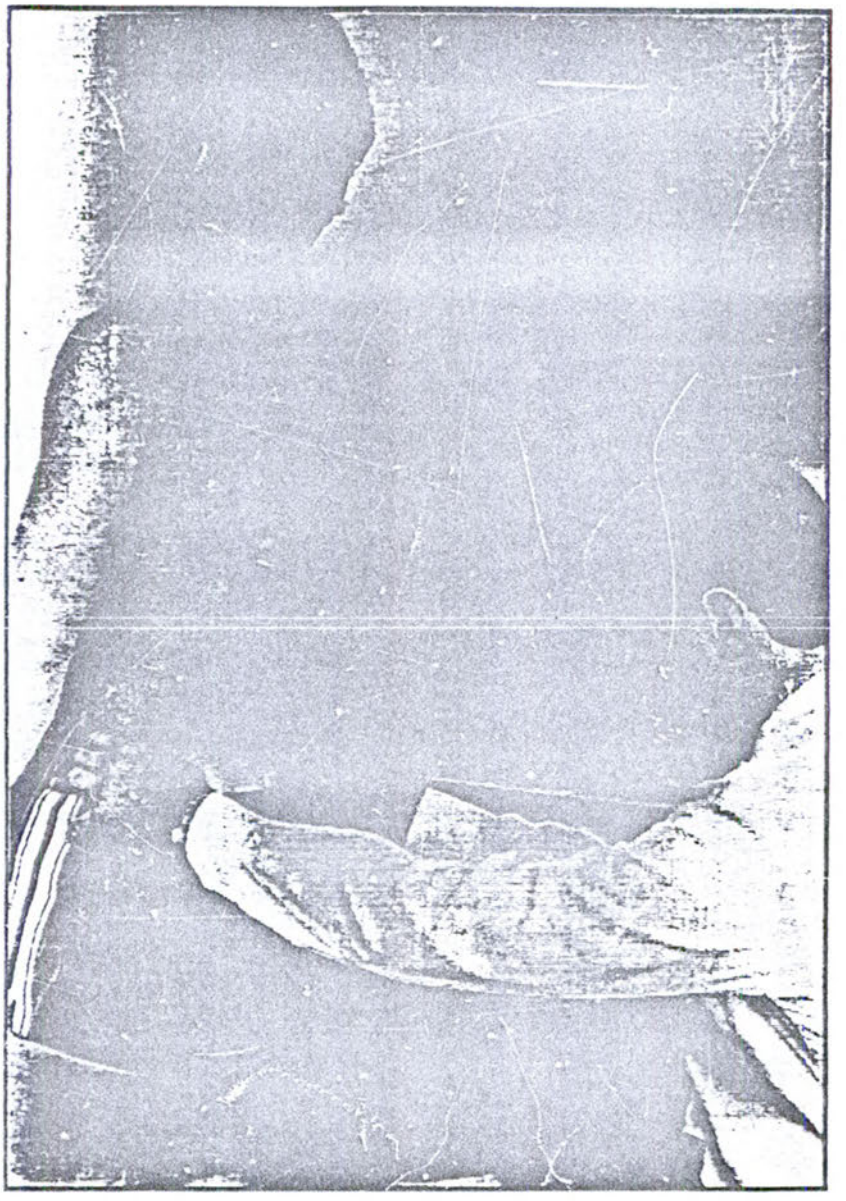

Figure 3. Posterior Superior Iliac Spine (PSIS) -- Posterior -- Standing

Posterior Superior Iliac Spine (PSIS) -- Posterior -- Standing

DESCRIPTION: Assessment of the levels of the PSISs visually, with subject in an erect standing posture.

INSTRUMENTS REQUIRED: None.

DEFINITION OF TERMS: None.

CONTRAINDICATIONS: Subject cannot attain or maintain the static erect standing position for a short period.

STARTING POSITION OF SUBJECT: Assumes a comfortable standing position with arms to the side, knees straight, and weight borne evenly on both feet.

STARTING POSITION OF EXAMINER: Seated on a stool in back of the subject.

PROCEDURE: The examiner places his or her thumbs beneath the anatomic area where the PSISs are located. The thumbs then are slid upward until they come into contact with the inferior slope of the PSISs, at which point the bones will stop further progression. The examiner makes a visual observation of the levels of the thumbs and records on the Recording Form if one PSIS (right or left) is higher than the other or if they are equal.

ORDER OF ASSESSMENTS: None.

TIMING: None.

REST PERIODS: None.

WHAT TO DO IF SUBJECT CANNOT ATTAIN OR MAINTAIN POSITION: Allow one minute of rest in the subject's most comfortable position. Try again; if that fails, abort the test, record N/A on the Recording Form, and indicate the reason for the failure.

INDICATIONS TO DISCONTINUE TEST: Failure on second attempt.

POSITION IN WHICH TO LEAVE SUBJECT: In the subject's most comfortable standing position.

COMMON ERRORS TO AVOID: The examiner not having his or her dominant eye positioned at the same level as the thumbs and midway between the two thumbs, not having the thumbs bilaterally on the same contact areas, having the subject stand on a floor that is not level, or allowing other joints of subject to influence the measurement (ie, inadvertent flexion at one hip or knee).

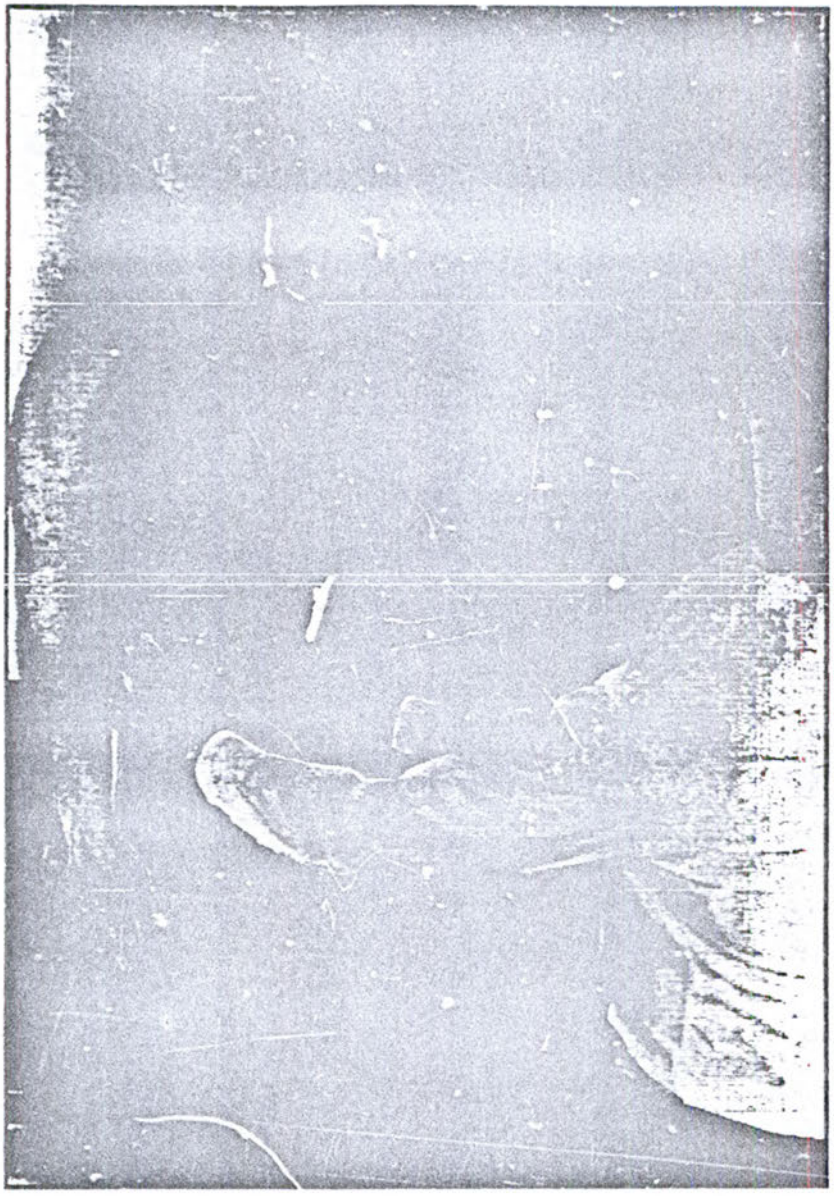

Figure 4. Iliac Crest -- Anterior -- Standing

Iliac Crest -- Anterior -- Standing

DESCRIPTION: Assessment of the levels of the iliac crests by the use of a crest tester, with subject in an erect standing posture.

INSTRUMENTS REQUIRED: Crest tester.

DEFINITION OF TERMS: None.

CONTRAINDICATIONS: Subject cannot attain or maintain the static erect standing position for a short period.

STARTING POSITION OF SUBJECT: Assumes a comfortable standing position with knees straight and weight borne evenly on both feet.

STARTING POSITION OF EXAMINER: Seated on a stool in front of the subject.

PROCEDURE: The examiner spreads the bars of the crest tester. Each of the bars then is placed an equal distance from the midline of the tester. The examiner then places the crest tester opening so that one bar is on the right side and the other on the left side of the subject's trunk. The examiner then slides the bars together so they are over the iliac crests and gently presses the bars down onto the iliac crests. The movement of the bars should be toward the midline, with care taken not to trap tissue superior to the iliac crests. The examiner observes the bubble level on the tester. The bubble will deviate toward the side of the high crest. The examiner makes a visual observation for bubble deviation and records results on the Recording Form that a crest is high on the right or on the left or that the crests are equal.

ORDER OF ASSESSMENTS: None.

TIMING: None.

REST PERIODS: None.

WHAT TO DO IF SUBJECT CANNOT ATTAIN OR MAINTAIN POSITION: Allow one minute of rest in the subject's most comfortable position. Try again; if that fails, abort the test, record N/A on the Recording Form, and indicate the reason for the failure.

INDICATIONS TO DISCONTINUE TEST: Failure on second attempt.

POSITION IN WHICH TO LEAVE SUBJECT: In the subject's most comfortable standing position.

COMMON ERRORS TO AVOID: The examiner not having his or her dominant eye positioned at the same level as the thumbs and midway between the two thumbs, not having the thumbs bilaterally on the same contact areas, not having the crest tester bars in symmetrical contact with the iliac crests, having the subject stand on a floor that is not level, or allowing other joints of subject to influence the measurement (ie, inadvertent flexion at one hip or knee).

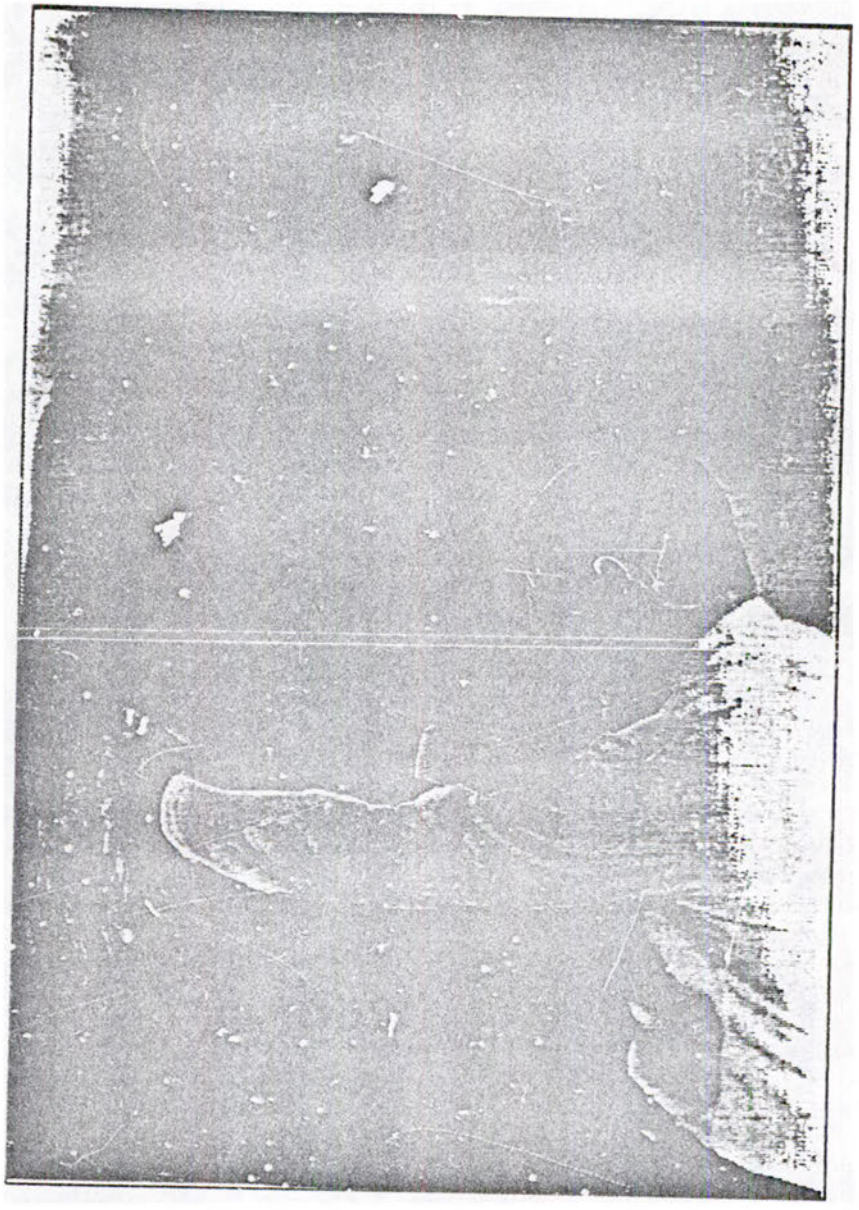

Figure 5. Anterior Superior Iliac Spine (ASIS) -- Anterior -- Standing

Anterior Superior Iliac Spine (ASIS) -- Anterior -- Standing

DESCRIPTION: Assessment of the levels of the ASISs visually, with subject in an erect standing posture.

INSTRUMENTS REQUIRED: None.

DEFINITION OF TERMS: None.

CONTRAINDICATIONS: Subject cannot attain or maintain the static erect standing position for a short period.

STARTING POSITION OF SUBJECT: Assumes a comfortable standing position with arms to the sides, knees straight, and weight borne evenly on both feet.

STARTING POSITION OF EXAMINER: Seated on a stool in front of the subject.

PROCEDURE: The examiner places his or her thumbs beneath the anatomic area where the the ASISs are located. The thumbs then are slid upward until they come into contact with the inferior slope of the ASISs. The examiner makes a visual observation of the levels of the thumbs and records on the Recording Form if one ASIS (right or left) is higher than the other or if they are equal.

ORDER OF ASSESSMENTS: None.

TIMING: None.

RESTING PERIOD: None.

WHAT TO DO IF SUBJECT CANNOT ATTAIN OR MAINTAIN POSITION: Allow one minute of rest in the subject's most comfortable position. Try again; if that fails, abort the test, record N/A on the Recording Form, and indicate the reason for the failure.

INDICATIONS TO DISCONTINUE TEST: Failure on second attempt.

POSITION IN WHICH TO LEAVE SUBJECT: In the subject's most comfortable standing position.

COMMON ERRORS TO AVOID: The examiner not having his or her dominant eye positioned at the same level as the thumbs and midway between the two thumbs, not having the thumbs on the same contact area, having the subject stand on a floor that is not level, or allowing other joints of subject to influence the measurement (ie, inadvertent flexion at one hip or knee).

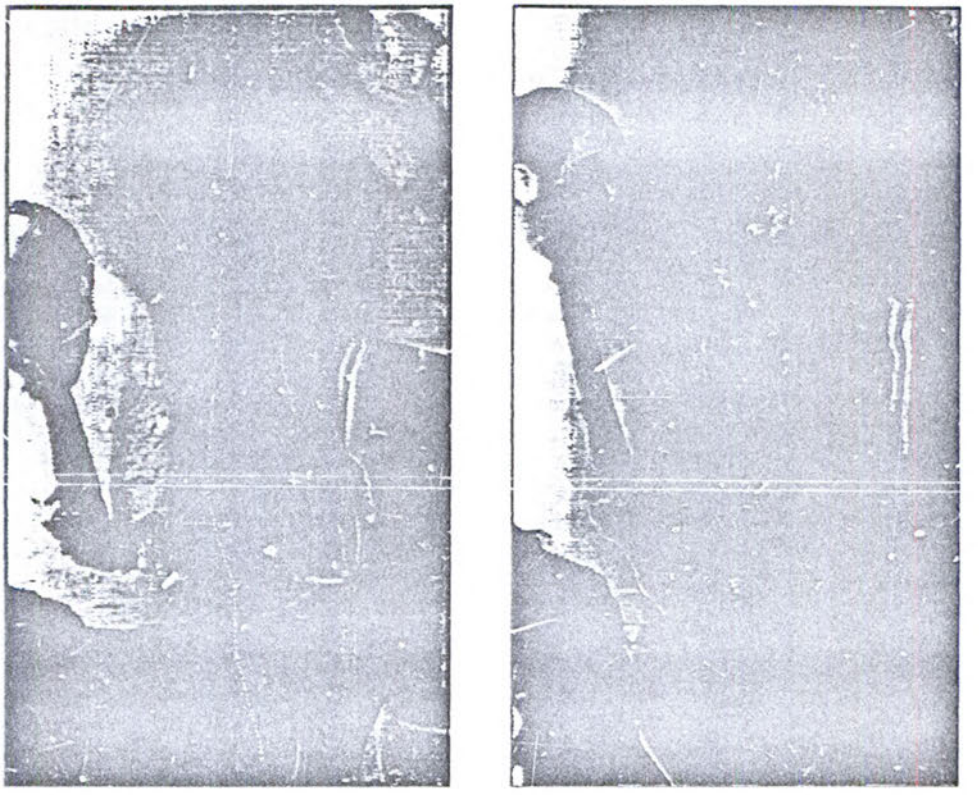

Figure 6. Side Bending to the Right and Left and Total Excursion of Motion Each Way

Side Bending to the Right and to the Left and Total Excursion of Motion Each Way

DESCRIPTION: Assessment of the range of motion of side bending of the lumbar spine by the use of a vertical ruler (in centimeters), with subject in an erect standing posture.

INSTRUMENTS REQUIRED: Flexible ruler, felt tip pen to mark anatomic structures, vertical ruler, and hand held calculator.

DEFINITIONS OF TERMS: None.

CONTRAINDICATIONS: Subject cannot attain or maintain the static erect standing position for a short period.

STARTING POSITION OF SUBJECT: Assumes a comfortable standing position with arms at the sides, knees straight, and weight borne evenly on both feet.

STARTING POSITION OF EXAMINER: Seated on a stool in back of the subject.

PROCEDURE: Testing is performed first to the right side and then to the left. The base of the vertical ruler is placed against the outer border of the subject's foot so that the middle finger of the subject's hand is at the midline of the meter stick. This measurement is recorded as the starting position. The subject is instructed to side bend to the right as far as possible without lifting the opposite heel off the floor. The start, finish, and excursion measurements (in centimeters) are recorded on the Recording Form. The entire procedure is repeated with side bending to the left.

ORDER OF ASSESSMENTS: Side bend first to the right first and then to the left.

TIMING: None.

REST PERIODS: None.

WHAT TO DO IF SUBJECT CANNOT ATTAIN OR MAINTAIN POSITION: Allow one minute of rest in the subject's most comfortable position. Try again; if that fails, abort the test, record N/A on the Recording Form, and indicate the reason for the failures.

INDICATIONS TO DISCONTINUE TEST: Failure on second attempt.

POSITION IN WHICH TO LEAVE SUBJECT: Allow the subject to sit comfortably on a table with knees flexed, weight borne evenly on both buttocks, and soles of the feet resting on a foot stool.

COMMON ERRORS TO AVOID: The examiner incorrectly transposing of numbers on the vertical ruler (eg, transposing a 6 or a 9 while the ruler is positioned opposite from the examiner).

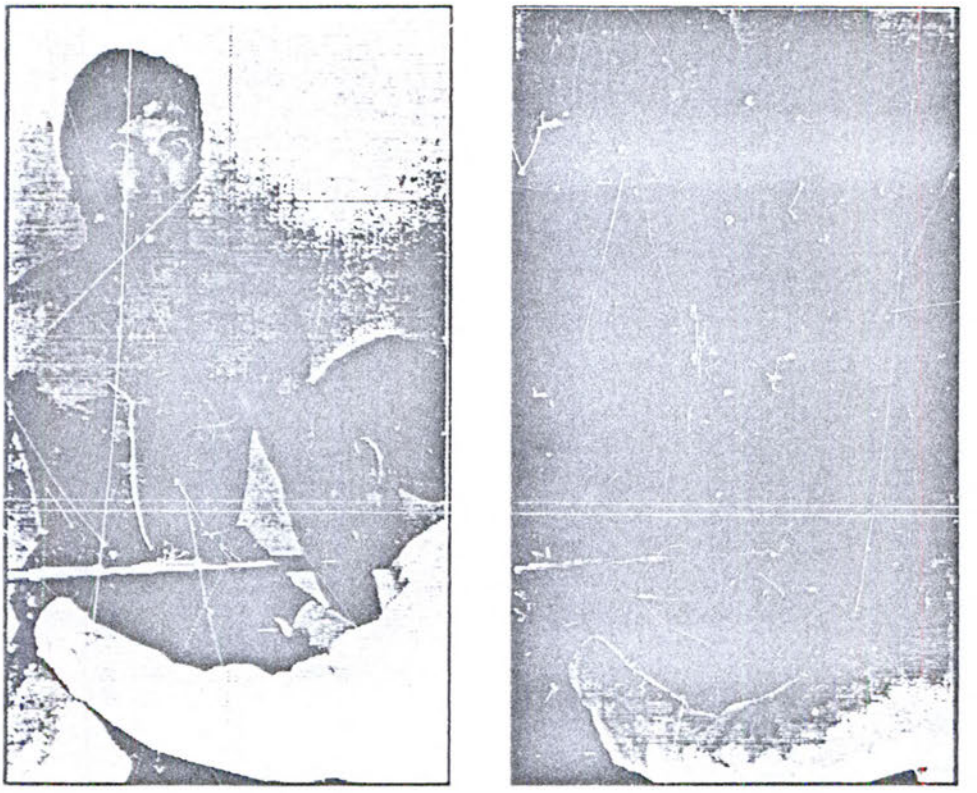

Figure 7. Iliac Crest -- Anterior and Posterior -- Sitting

Iliac Crest -- Anterior and Posterior -- Sitting

DESCRIPTION: Assessment of the levels of the iliac crests by the use of a crest tester, with subject in a relaxed seated posture.

INSTRUMENTS REQUIRED: Crest tester.

DEFINITION OF TERMS: None.

CONTRAINDICATIONS: Subject cannot attain or maintain the static seated position for a short period.

STARTING POSITION OF SUBJECT: Assumes a comfortable seated position with knees flexed, weight borne evenly on both buttocks, and soles of the feet resting on a foot stool.

STARTING POSITION OF EXAMINER: Seated on a stool in front of and then in back of the subject (see ORDER OF ASSESSMENTS).

PROCEDURE: The examiner spreads the bars of the crest tester. Each of the bars then is placed an equal distance from the midline of the tester. The examiner then places the crest tester opening so that one bar is on the right side and the other on the left side of the subject's trunk. The examiner then slides the bars together so they are over the iliac crests and gently presses the bars down onto the iliac crests. The movement of the bars should be toward the midline with care taken not to trap tissue superior to the iliac crests. The examiner observes the bubble level on the tester. The bubble will deviate toward the side of the high crest. The examiner makes a visual observation for bubble deviation and records results on the Recording Form that a crest is high on right or on the left or that the crests are equal. Repeat the entire process from the back of the subject.

ORDER OF ASSESSMENTS: First the anterior crest levels and then the posterior crest levels.

TIMING: None.

REST PERIODS: None.

WHAT TO DO IF SUBJECT CANNOT ATTAIN OR MAINTAIN POSITION: Allow one minute of rest in the subject's most comfortable position. Try again; if that fails, abort the test, indicate N/A on the Recording Form, and explain the reason for the failure.

INDICATIONS TO DISCONTINUE TEST: Failure on second attempt.

POSITION IN WHICH TO LEAVE THE SUBJECT: In a comfortable seated position.

COMMON ERRORS TO AVOID: The examiner not having his or her dominant eye positioned at the same level as the thumbs and midway between the two thumbs; not having the thumbs bilaterally on the same contact areas, not having the crest tester bars in symmetrical contact with the iliac crests, or using a table that is not level.

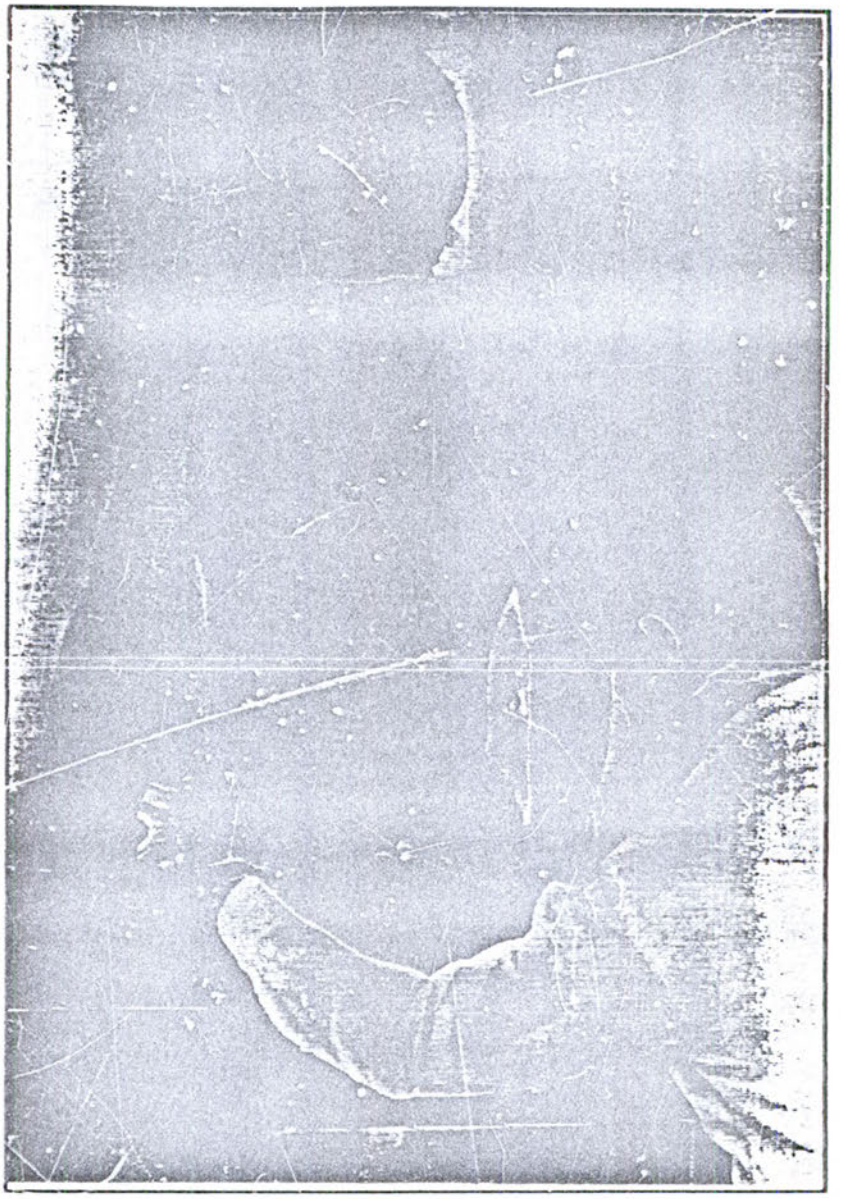

Figure 8. Posterior Superior Iliac Spine (PSIS) -- Posterior -- Sitting

Posterior Superior Iliac Spine (PSIS) -- Posterior -- Sitting

DESCRIPTION: Assessment of the levels of the PSISs visually, with subject at rest in the comfortable seated position.

INSTRUMENTS REQUIRED: None.

DEFINITION OF TERMS: None.

CONTRAINDICATIONS: Subject cannot attain or maintain a static seated position.

STARTING POSITION OF SUBJECT: Assumes a comfortable seated position with knees flexed, weight borne evenly on both buttocks, and soles of the feet resting on a foot stool.

STARTING POSITION OF EXAMINER: Seated on a stool in back of the subject.

PROCEDURE: The examiner places his or her thumbs beneath the anatomic areas where the PSISs are located. The thumbs then are slid upward until they come into contact with the inferior slope of the PSISs, at which point the bones will stop further progression. The examiner palpates the PSISs with the thumbs, makes a visual observation of the levels of the thumbs, and records on the Recording Form if one PSIS (right or left) is higher than the other or if they are equal.

ORDER OF ASSESSMENTS: None.

TIMING: None.

REST PERIODS: None.

WHAT TO DO IF SUBJECT CANNOT ATTAIN OR MAINTAIN POSITION: Allow one minute of rest in the subject's most comfortable position. Try again; if that fails, abort the test, record N/A on the Recording Form, and indicate the reason for the failure.

INDICATIONS TO DISCONTINUE TEST: N/A.

POSITION IN WHICH TO LEAVE SUBJECT: In a comfortable seated posture.

COMMON ERRORS TO AVOID: The examiner not having his or her dominant eye positioned at the same level as the thumbs and midway between the two thumbs, not having the thumbs bilaterally on the same contact areas, failing to maintain thumb contact with the PSISs, or using a table that is not level.

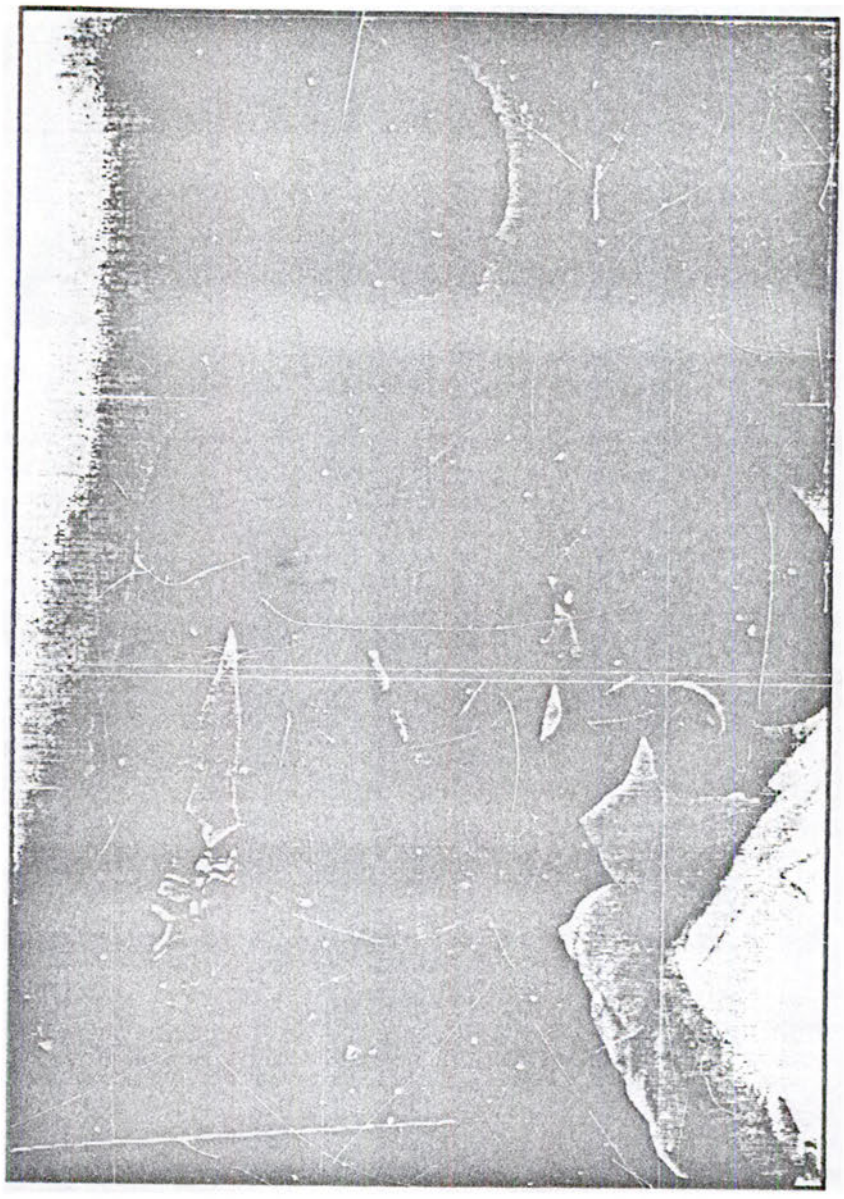

Figure 9. *Lumbar Lordosis -- Flexible Ruler -- Relaxed Sitting*

Lumbar Lordosis -- Flexible Ruler -- Relaxed Sitting

DESCRIPTION: Measurement of the degrees of of the lumbar spine lordosis in the sagittal plane by the use of a flexible ruler.

INSTRUMENTS REQUIRED: Flexible ruler and felt tip pen to mark anatomic structures.

DEFINITION OF TERMS: None.

CONTRAINDICATIONS: Subject cannot assume a static relaxed seated position for a short time period or cannot tolerate the necessary pressure involved to conform the ruler to the lumbar spine.

STARTING POSITION OF SUBJECT: Assumes a relaxed sitting position.

STARTING POSITION OF EXAMINER: Seated on a stool in back of the subject.

PROCEDURE: The examiner places his or her thumbs beneath anatomic area where the posterior superior iliac spines (PSISs) are located. The thumbs then are slid upward until they come into contact with the inferior slope of the PSISs, at which point the bones will stop further progression. The examiner draws an imaginary line between the two palpating thumbs. A marking dot is placed at the midpoint of that imaginary line. The palpating thumbs put pressure over the spinous process of L5 (marking dot at the midpoint) and subsequent spinous processes as the examiner sequentiality palpates up the spine to T12. Another marking dot is placed in the interspinous space between T12 and L1. The flexible ruler is placed against the subject's back, with the bottom end of the ruler lined up with the lower marking dot (L5). The flexible ruler then is conformed to the subject's lumbar spine, and a pencil mark is made on the ruler where it lines up with the upper marking dot (L1). The ruler is removed from the subject's back and placed on the Recording Form. A tracing is made of the ruler from the side that was touching the subject. The tracing should be from the bottom end of the ruler (L5) to the pencil mark (L1). The degree angle of lordosis is calculated (Attachment A). The degree angle is recorded on the Recording Form.

ORDER OF ASSESSMENTS: None.

TIMING: None.

REST PERIODS: None.

WHAT TO DO IF SUBJECT CANNOT ATTAIN OR MAINTAIN POSITION: Allow one minute of rest in the subject's most comfortable position. Try again; if that fails, abort the test, record N/A on the Recording Form, and explain the reason for the failure.

INDICATIONS TO DISCONTINUE TEST: Failure on second attempt.

POSITION IN WHICH TO LEAVE SUBJECT: In a comfortable seated posture.

COMMON ERRORS TO AVOID: The examiner not having his or her dominant eye positioned at the same level as the thumbs and midway between the two thumbs, not having the thumbs bilaterally on the same contact areas, miscounting levels, not locating the junction of the sacrum and the lumbar spine, failing to use enough pressure to conform the ruler to the bones over the interposing soft tissue, or using a table that is not level.

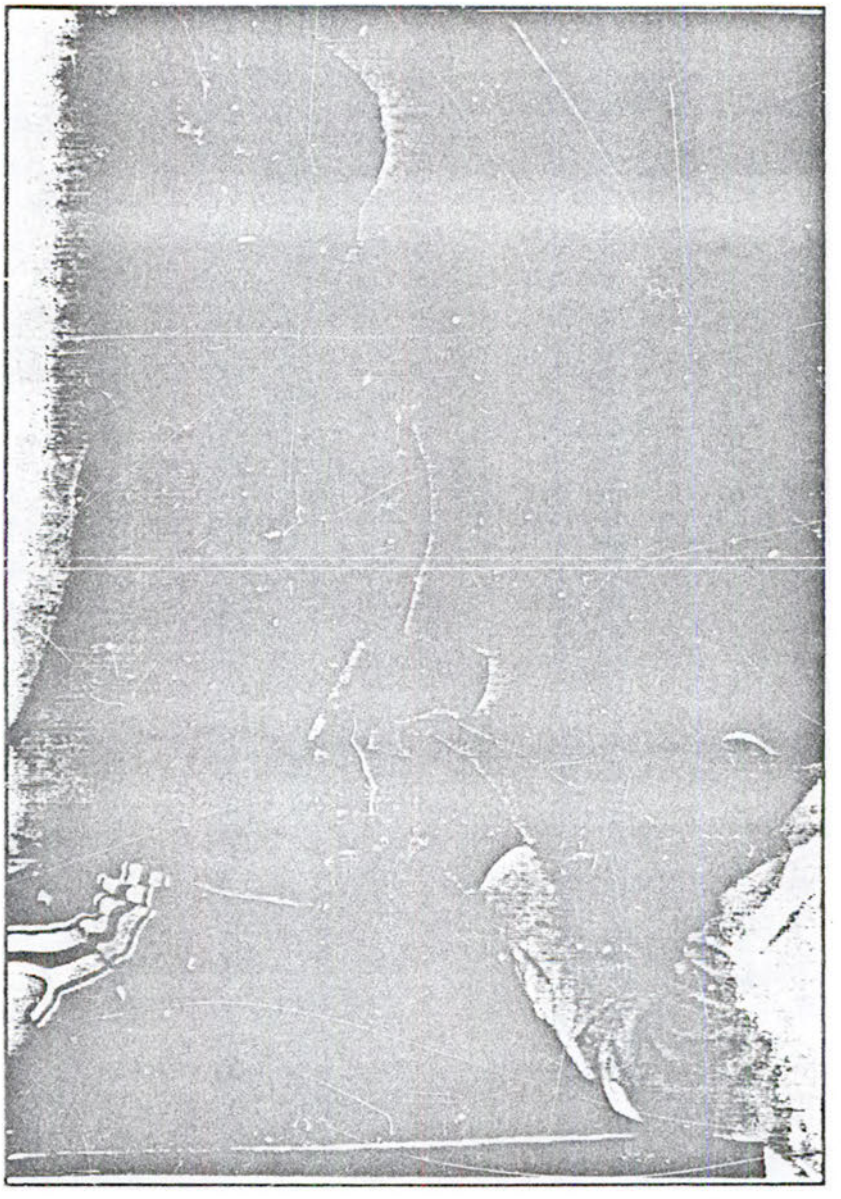

Figure 10. Lumbar Lordosis -- Flexible Ruler -- Sustained Erect Sitting

Lumbar Lordosis -- Flexible Ruler -- Sustained Erect Sitting

DESCRIPTION: Assessment of the lordotic shape of the lumbar spine in the sagittal plane as measured by a flexible ruler, with the subject in a sustained erect sitting position.

INSTRUMENTS REQUIRED: Clock, flexible ruler, and felt tip pen to mark anatomic structures.

DEFINITION OF TERMS: None.

CONTRAINDICATIONS: Peripheralization of symptoms with brief sitting or cannot tolerate the necessary pressure involved to conform the ruler to the lumbar spine.

STARTING POSITION OF SUBJECT: Assumes a relaxed seated position with the knees flexed, weight borne evenly on both buttocks, and soles of the feet resting on a foot stool.

STARTING POSITION OF EXAMINER: Seated on a stool in back of the subject.

PROCEDURE: The examiner instructs the subject to sit up as straight as possible and to maintain this position for two minutes. If the subject sits erect normally, this test should be preceded with the sustained slouched sitting test. The examiner places his or her thumbs beneath the anatomic area where the posterior superior iliac spines (PSISs) are located. The thumbs then are slid upward until they come into contact with the inferior slope of the PSISs, at which point the bones will stop further progression. The examiner draws an imaginary line between the two palpating thumbs. A marking dot is placed at the midpoint of that imaginary line. The palpating thumbs put pressure over the spinous process of L5 (marking dot at the midpoint) and subsequent spinous processes as the examiner sequentially palpates up the spine to T12. Another marking dot is placed in the interspinous space between T12 and L1. The flexible ruler is placed against the subject's back, with the bottom end of the ruler lined up with the lower marking dot (L5). The flexible ruler then is conformed to the subject's lumbar spine, and a pencil mark is made on the ruler where it lines up with the upper marking dot (L1). The ruler is removed from the subject's back and placed on the Recording Form. A tracing is made of the ruler from the side that was touching the subject. The tracing should be from the the bottom end of the ruler (L5) to the pencil mark (L1). The degree angle of lordosis is calculated (Attachment A). The degree angle is recorded on the Recording Form.

ORDER OF ASSESSMENTS: None.

TIMING: 120 seconds.

REST PERIODS: None.

WHAT TO DO IF SUBJECT CANNOT ATTAIN OR MAINTAIN POSITION: Allow one minute of rest in the subject's most comfortable position. Try again; if that fails, abort the test, record N/A on the Recording Form, and indicate the reason for the failure.

INDICATIONS TO DISCONTINUE TEST: Symptoms worsen, increase, or peripheralize.

POSITION IN WHICH TO LEAVE SUBJECT: In a comfortable seated position.

COMMON ERRORS TO AVOID: The examiner not having his or her dominant eye positioned at the same level as the thumbs and midway between the two thumbs, not having the thumbs bilaterally on the same contact areas, miscounting levels, locating the junction of the sacrum and the lumbar spine, failing to use enough pressure to conform the ruler to the bones over the interposing soft tissue, or using a table that is not level.

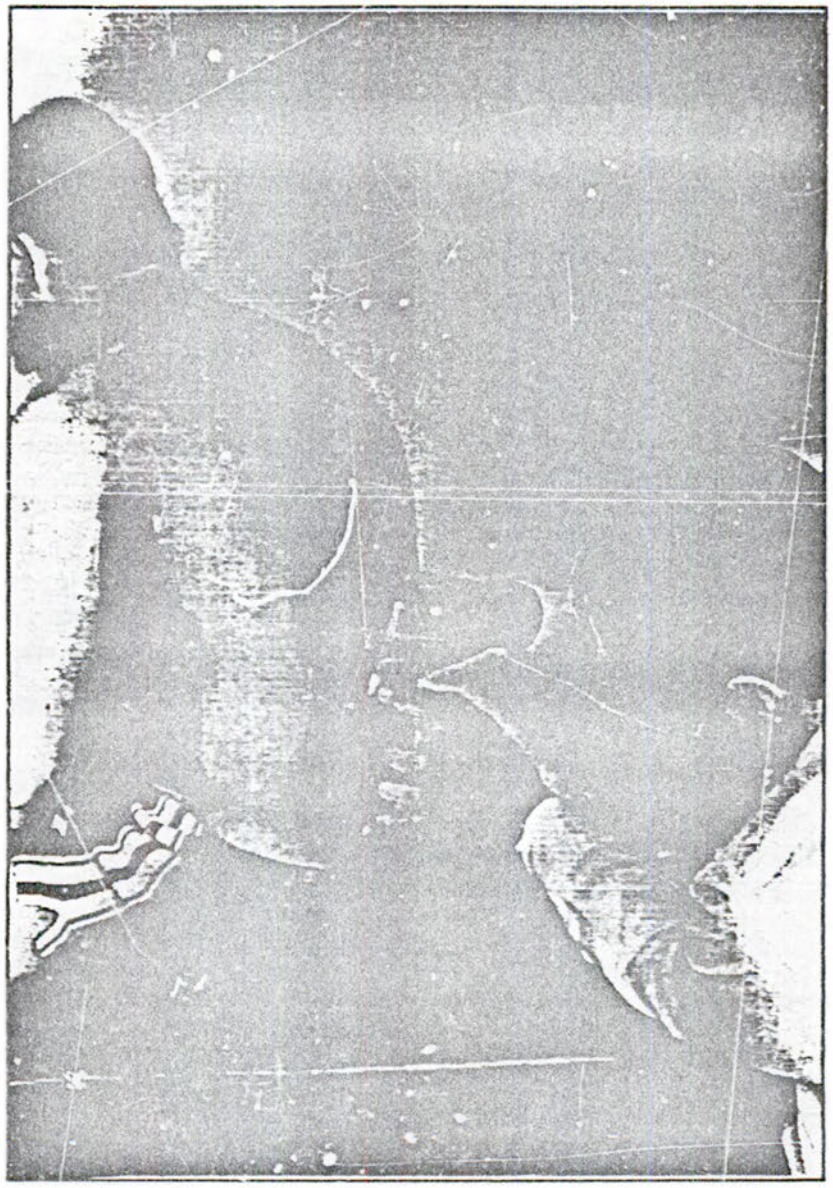

Figure 11. Lumbar Lordosis -- Flexible Ruler -- Sustained Slouched Sitting

Lumbar Lordosis -- Flexible Ruler -- Sustained Slouched Sitting

DESCRIPTION: Assessment of the lordotic shape of the lumbar spine in the sagittal plane, as measured by a flexible ruler, with the subject in a sustained slouched seated posture.

INSTRUMENTS REQUIRED: Clock, flexible ruler, and felt tip pen to mark anatomic structures.

DEFINITION OF TERMS: None.

CONTRAINDICATIONS: Peripheralization of symptoms with brief sitting or cannot tolerate the necessary pressure involved to conform the ruler to the lumbar spine.

STARTING POSITION OF SUBJECT: Assumes a relaxed seated position with the knees flexed, weight borne evenly on both buttocks, and soles of the feet resting on a foot stool.

STARTING POSITION OF EXAMINER: Seated on a stool in back of the subject.

PROCEDURE: The examiner instructs the subject to slouch forward as much as possible and to maintain this position for two minutes. While the subject is slouched forward, a flexible ruler measurement is taken of the lumbar spine. The examiner places his or her thumbs beneath the anatomic area where the posterior superior iliac spines (PSISs) are located. The thumbs then are slid upward until they come into contact with the inferior slope of the PSISs, at which point the bones will stop further progression. The examiner draws an imaginary line between the two palpating thumbs. A marking dot is placed at the midpoint of that imaginary line. The palpating thumbs put pressure over the spinous process of L5 (marking dot at the midpoint) and subsequent spinous processes as the examiner sequentially palpates up the spine to T12. Another marking dot is placed in the interspinous space between T12 and L1. The flexible ruler is placed against the subject's back, with the bottom end of the ruler lined up with the lower marking dot (L5). The flexible ruler then is conformed to the subjects lumbar spine, and a pencil mark is made on the ruler where it lines up with the upper marking dot (L1). The ruler is removed from the subject's back and placed on the Recording Form. A tracing is made of the ruler from the side that was touching the subject. The tracing should be from the bottom end of the ruler (L5) to the pencil mark (L1). The degree angle of lordosis is calculated (Attachment A). The degree angle is recorded on the Recording Form.

ORDER OF ASSESSMENTS: None.

TIMING: 120 seconds

REST PERIODS: None.

WHAT TO DO IF SUBJECT CANNOT ATTAIN OR MAINTAIN POSITION: Allow one minute of rest in the subject's most comfortable position. Try again; if that fails, abort the test, record N/A on the Recording Form, and indicate the reason for the failure.

INDICATIONS TO DISCONTINUE TEST: Symptoms worsen, increase, or peripheralize.

POSITION IN WHICH TO LEAVE SUBJECT: Subject may move to a relaxed prone position.

COMMON ERRORS TO AVOID: The examiner not having his or her dominant eye positioned at the same level as the thumbs and midway between the two thumbs, not having the thumbs bilaterally on the same contact areas, miscounting levels, not locating the junction of the sacrum and the lumbar spine, failing to use enough pressure to conform the ruler to the bones over the interposing soft tissue, or using a table that is not level.

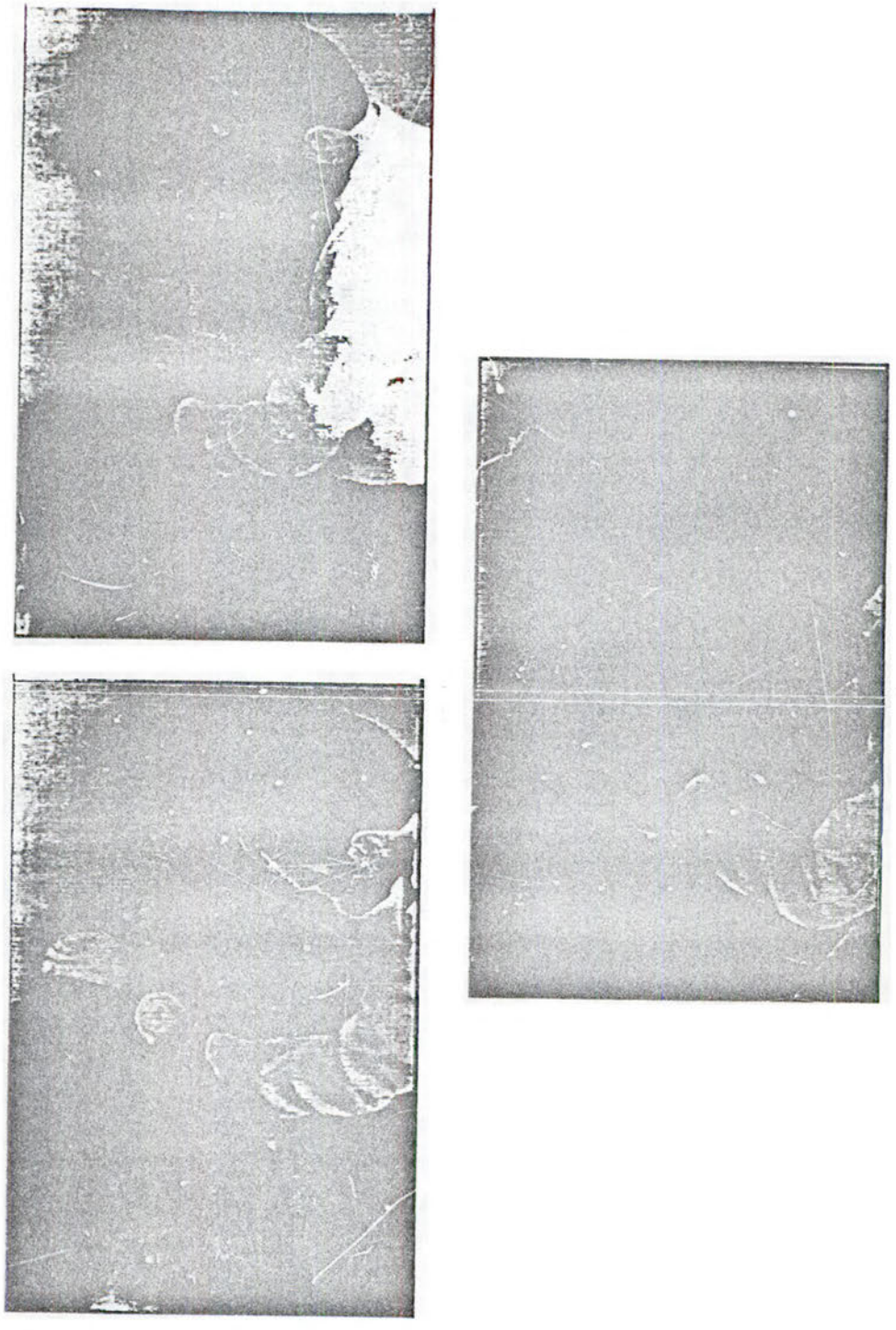

Figure 12. *Hip Joint Rotation Range of Motion (ROM), with Subject in a Prone Position*

Hip Joint Range of Motion (ROM), with Subject in a Prone Position

DESCRIPTION: Goniometric measurement of the passive ROM of internal (medial) and external (lateral) rotation of the right and left hip joints, with subject in a prone position.

INSTRUMENTS REQUIRED: Gravity goniometer

DEFINITION OF TERMS: None.

CONTRAINDICATION: Subject cannot assume a static prone position for a short period.

STARTING POSITION OF SUBJECT: Assumes a prone-lying position on the table.

STARTING POSITION OF EXAMINER: Standing on the right side of the table next to to the subject.

PROCEDURE: The first measurement is done on the right hip. The examiner instructs the subject to slide to the left side of the table. The subject's knees are placed together. The examiner moves the right knee to 90 degrees of flexion so that the sole of the right foot faces the ceiling. The left leg is extended. The examiner positions the goniometer so that it aligns with the long axis of the tibia on the right leg and sets the zero point on the gravity goniometer. First, the examiner measures and records internal rotation and returns the leg to the starting position. Then external rotation is measured and recorded. The degrees of internal and external rotation are measured to the nearest 5 degree interval and recorded on the Recording Form.

To measure the left hip, the examine instructs the subject to slide to the right side of the table. The subject's knees are placed together. The examiner moves the left knee to 90 degrees of flexion so that the sole of the left foot faces the ceiling. The right leg is extended. The examiner aligns the goniometer with the long axis of the tibia of the left leg and sets the zero point on the gravity goniometer. First, the examiner measures and records internal rotation and returns the leg to the starting position. Then external rotation is measured and recorded. The degrees of internal and external rotation are measured to the nearest 5 degree interval and recorded on the Recording Form.

ORDER OF ASSESSMENTS: First the right leg and then the left leg.

TIMING: None.

REST PERIODS: None.

WHAT TO DO IF SUBJECT CANNOT ATTAIN OR MAINTAIN POSITION: Allow one minute of rest in the subject's most comfortable position. Then try again; if that fails, abort the test, record N/A on the Recording Form, and explain the reason for the failure.

INDICATIONS TO DISCONTINUE TEST: Failure on second attempt.

POSITION IN WHICH TO LEAVE SUBJECT: In a prone position.

COMMON ERRORS TO AVOID: Moving the limb too far so that the pelvis on the side opposite to the movement begins to lift off the table.

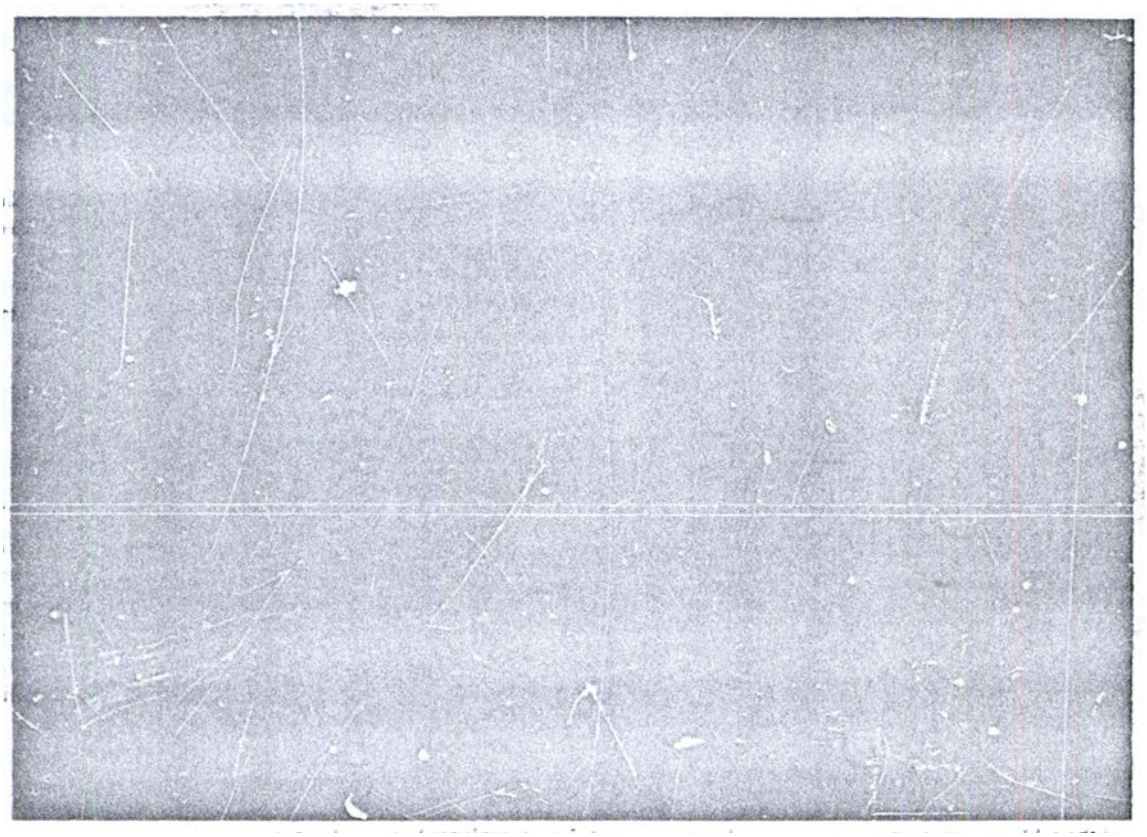

Figure 13. Sustained Extension in Prone Lying -- Press-up Symptom Change

Sustained Extension in Prone Lying -- Press-up Symptom Change

DESCRIPTION: Assessment of the change in symptoms with sustained extension in prone-lying.

INSTRUMENTS REQUIRED: Clock.

DEFINITION OF TERMS: None.

CONTRAINDICATION: Peripheralization of symptoms with prone-lying. Peripheralization is defined as the symptoms moving from the low back to the distal portion of the either extremity or both extremities.

STARTING POSITION OF SUBJECT: Assumes a comfortable prone-lying position with the palmar surface of the hands placed on the table top so they are aligned under each shoulder joint.

STARTING POSITION OF EXAMINER: Either seated or standing at the side of the table.

PROCEDURE: The examiner instructs the subject to place the palmar surfaces of his or her hands beneath his or her shoulders, as if performing a prone push-up. Before the test, the subject is asked if he or she feels any pain, numbness, tingling, or pins and needles in any area of the body while lying in that resting position. The subject next is instructed to extend the elbows, thus pushing the head and shoulders up and away from the table while letting the lower lumbar spine sag into an extended position. The subject is told to maintain this position for a maximum of 30 seconds and to indicate whether there is any change in symptoms. After a maximum of 30 seconds, the subject is allowed to resume a prone-lying position. The examiner asks if there has been any change in symptoms with the returning movement or at the starting position.

Record the results on the Recording Form. If there is no change in symptoms with the procedure or if the test is contraindicated, check the appropriate response and proceed to the next test. If the subject performs the test and reports changes, complete Grid A and B according to the following instructions. Grid A: Check the appropriate block for back, right leg, or left leg pain use symbols as noted in key. If pain is felt at rest, for example; place and X in the appropriate box under the Before initiation column. Use the Symptoms at initiation column to record changes coincident with the start of the test. Use the Symptom at Termination column to record changes present when the neutral position is resumed. Use the Time to Onset column is used to indicate the time (in seconds) required to produce an alteration in symptoms or until the end of the test. Use the After Termination column to record any changes in symptoms that develop after the end of the procedure. Grid B: Use it identically to that of Grid A, except record paresthesia rather than pain.

ORDER OF ASSESSMENTS: None

TIMING: 30 seconds

REST PERIODS: None.

WHAT TO DO IF SUBJECT CANNOT ATTAIN OR MAINTAIN POSITION: Allow one minute of rest in the subject's most comfortable position. Try again; if that fails, abort the test, record N/A on the Recording Form, and explain the reason for the failure.

INDICATIONS TO DISCONTINUE TEST: Symptoms worsen, increase or peripheralize.

POSITION IN WHICH TO LEAVE SUBJECT: Move the subject to a back-lying position.

COMMON ERRORS TO AVOID: None.

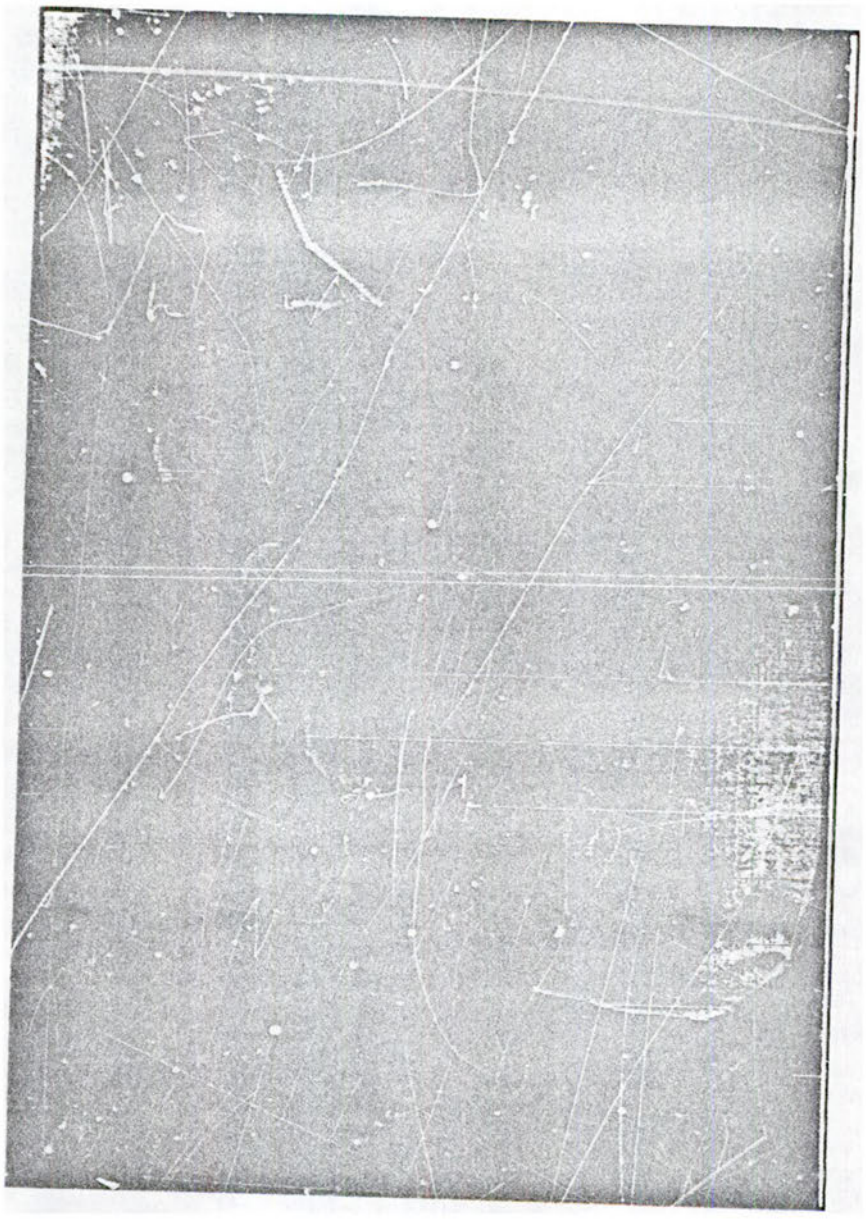

Figure 14. Single Straight Leg Raising

Single Straight Leg Raising

DESCRIPTION: Measurement of a passive straight leg raising by gravity goniometer.

INSTRUMENTS REQUIRED: Gravity goniometer.

DEFINITION OF TERMS: None.

CONTRAINDICATION: Subject cannot assume the starting position.

STARTING POSITION OF SUBJECT: Assumes a supine-lying position with hips and knees extended.

STARTING POSITION OF EXAMINER: Standing at the side of the examining table and by the extremity being measured.

PROCEDURE: The examiner positions the gravity goniometer so that it aligns with the long axis of the fibula on the examined leg and sets the zero point on the gravity goniometer. If there is a symptomatic leg, the asymptomatic leg is tested first. For testing the left leg, the examiner's left hand is placed on the posterior aspect of the ankle, just proximal to the calcaneus, while the thumb and fingers clasp the goniometer. The right hand grasps the superior portion of lower thigh just above the knee, while the fingers wrap around the thigh and palpate the medial hamstring muscle tendons. The examiner slowly raises the leg from the table until no more motion is permitted by muscle tightness in the hamstring muscles as palpated by the fingers. The examiner reads the goniometer to the nearest 5 degree interval and records the angle on the Assessment Form. The leg then is lowered; the examiner moves to the other side of the table; and the same procedure is repeated on the other side, with hands reversed.

ORDER OF ASSESSMENTS: First the asymptomatic side and then the symptomatic side. If there is no symptomatic side, start with the right leg.

TIMING: None.

REST PERIODS: None.

WHAT TO DO IF SUBJECT CANNOT ATTAIN OR MAINTAIN POSITION: Allow one minute of rest in the subject's most comfortable position. Try again; if that fails, abort the test.

INDICATIONS TO DISCONTINUE TEST: Failure on second attempt.

POSITION IN WHICH TO LEAVE SUBJECT: A supine-lying position.

COMMON ERRORS TO AVOID: In the examined limb, the knee is not maintained in terminal extension, hip rotation is not controlled in a neutral position, and hip abduction and adduction are not controlled in a neutral position. In the contralateral lower extremity, the position changes. In the pelvis; movement occurs on the side opposite the extremity being tested.

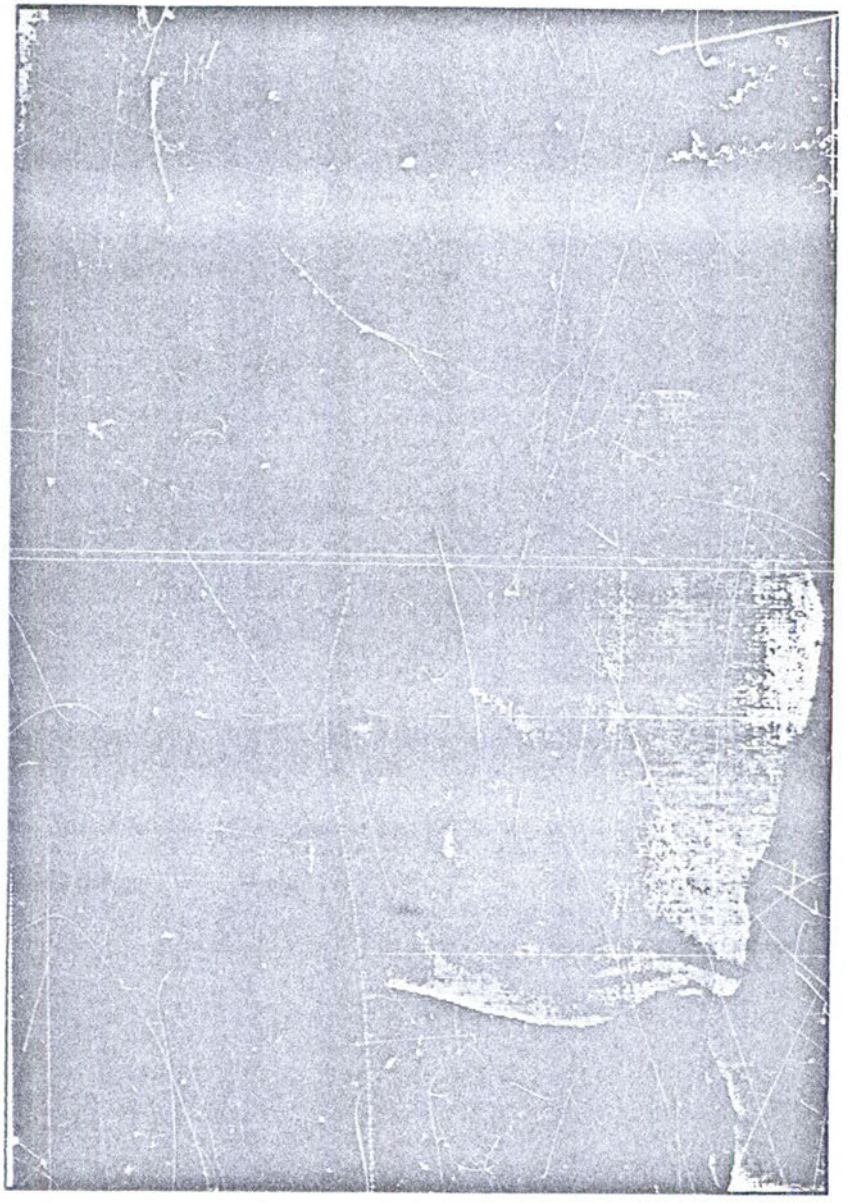

Figure 15. Double Straight Leg Raising

Double Straight Leg Raising

DESCRIPTION: A measurement of passive double straight leg raising by a gravity goniometer.

INSTRUMENTS REQUIRED: Gravity goniometer.

DEFINITION OF TERMS: None.

CONTRAINDICATIONS: Subject cannot assume the starting position.

STARTING POSITION OF SUBJECT: Assumes a supine-lying position with hips and knees extended.

STARTING POSITION OF EXAMINER: Standing at the side of the examining table and near the lower extremities.

PROCEDURE: The examiner positions the gravity goniometer so that it aligns with the long axis of the fibula on the nearest examined leg and sets the zero point of the gravity goniometer. If standing on the left side of the subject, the examiner places his or her left hand on the posterior aspect of the ankle, just proximal to the calcaneus, while clasping the goniometer with the thumb and fingers. The right hand crosses both of the lower thighs just proximal to the knee, while the fingers wrap around the contralateral thigh to palpate the medial hamstring muscle tendon. The examiner slowly raises the legs from the table until no more motion is permitted by the tightness in the hamstring muscles as palpated by the fingers. The examiner reads the goniometer to the nearest 5 degree interval and records the angle on the Recording Form. The legs then are lowered.

ORDER OF ASSESSMENTS: None.

TIMING: None.

REST PERIODS: None.

WHAT TO DO IF SUBJECT CANNOT ATTAIN OR MAINTAIN POSITION: Allow one minute of rest in the subject's most comfortable position. Try again; if that fails, abort the test.

INDICATIONS TO DISCONTINUE TEST: Failure on second attempt.

POSITION IN WHICH TO LEAVE SUBJECT: In supine-lying position.

COMMON ERRORS TO AVOID: In the examined limbs, the knees are not maintained in terminal extension, hip rotation is not controlled in a neutral position, and hip abduction and adduction are not controlled in a neutral position.

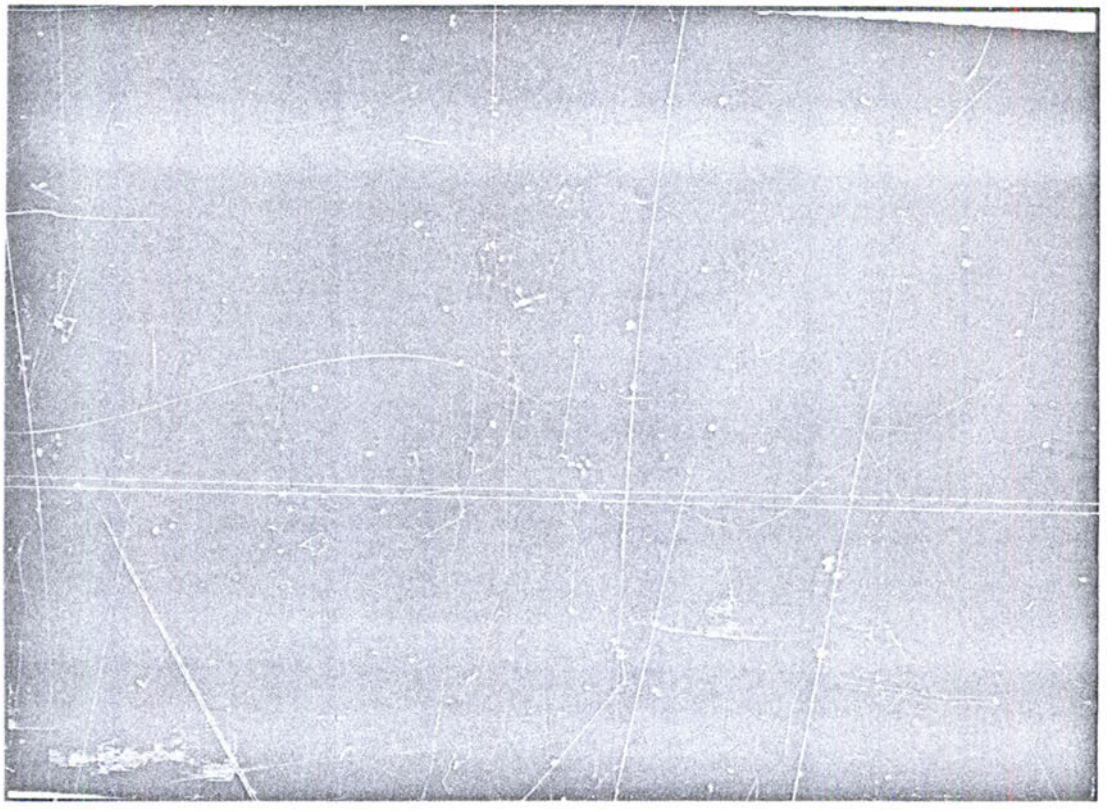

Figure 16. Hamstring Length

Hamstring Length

DESCRIPTION: A measure that represents the relative length of the right and the left hamstring muscles by the use of a gravity goniometer.

INSTRUMENTS REQUIRED: Gravity goniometer.

DEFINITION OF TERMS: None.

CONTRAINDICATION: Peripheralization of pain with assumption of the test starting position.

STARTING POSITION OF SUBJECT: Assumes a relaxed supine position with the lower limb being measured in 90 degrees of hip joint flexion.

STARTING POSITION OF EXAMINER: Standing at the side of the examining table and by the extremity being measured.

PROCEDURE: Before testing, the examiner moves each leg segment of each lower extremity of the subject to assess passive range of motion. The nonmeasured lower extremity is placed in a position of hip and knee flexion, with the heel of that foot in line with the midpatella region of the extremity being measured. The examiner positions the gravity goniometer so that it aligns with the long axis of the fibula on the examined leg and sets the zero point of the gravity goniometer. Testing order is the right leg first, then the left. The right leg is placed in 90 degrees of hip flexion and passive knee flexion. The examiner uses the right hand to maintain the position of the goniometer against the long axis of the fibula of the lower leg and uses the left hand to palpate the hamstring muscle tendons. The examiner extends the knee joint until tension is felt in the hamstring tendons. The degree of flexion/extension from the goniometer is recorded on the Recording Form. The knee then is returned to the starting position, the examiner moves to the other side of the table, and the procedure is repeated on the left lower extremity. Upon completion of testing on both sides, the subject is allowed to resume a supine-lying position while the examiner records the angle on the Recording Form.

ORDER OF ASSESSMENTS: First the right leg and then the left leg.

TIMING: None.

REST PERIODS: None.

WHAT TO DO IF SUBJECT CANNOT ATTAIN OR MAINTAIN POSITION: Allow one minute of rest in the subject's most comfortable position. Try again; if that fails, abort the test.

INDICATIONS TO DISCONTINUE TEST: Failure on second attempt.

POSITION IN WHICH TO LEAVE SUBJECT: In a supine-lying position.

COMMON ERRORS TO AVOID: In the lower extremity being tested, the hip is not maintained in 90 degrees of flexion or the knee joint is stretched into extension past the point of initial tension.

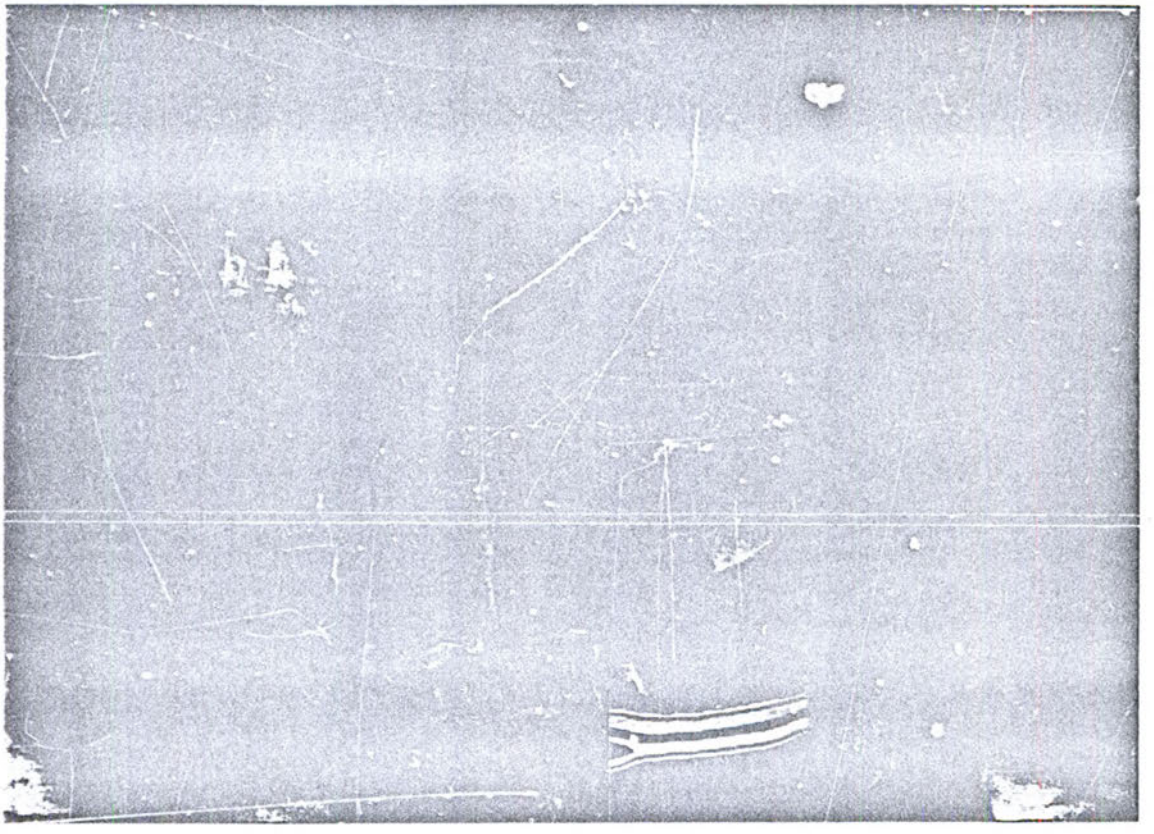

***Figure** 7. Hip Flexor Muscle Strength (Iliopsoas) Marginal Reliability*

Hip Flexor Muscle Strength (Iliopsoas)

[MARGINAL RELIABILITY]

DESCRIPTION: Isometric assessment of the strength equality of the iliopsoas muscle group from right to left.

INSTRUMENTS REQUIRED: None.

DEFINITION OF TERMS: None.

CONTRAINDICATION: Peripheralization of symptoms with assumption of the starting position of the test.

STARTING POSITION OF SUBJECT: The measured extremity is in hip and knee flexion, with the sole of the foot flat on the table. The nonmeasured extremity is in full extension at the hip and knee.

STARTING POSITION OF EXAMINER: Standing at the side of the examining table and by the extremity being measured.

PROCEDURE: The right hip flexor strength is assessed first. The examiner places the right hip in 90 degrees flexion and 90 degrees knee flexion. While stabilizing the left knee in the noted starting position, the examiner applies resistance to the right proximal portion of the knee. The muscle strength of the iliopsoas on the right side is assessed. The right hip and knee are returned to the neutral position, the examiner moves to the left side of the subject, and repeats the test. The relative equality of iliopsoas muscle strength is recorded on the Recording Form. The subject is allowed to resume a relaxed supine-lying position.

ORDER OF ASSESSMENTS: First the right side and then the left side.

TIMING: None.

REST PERIODS: None.

WHAT TO DO IF SUBJECT CANNOT ATTAIN OR MAINTAIN POSITION: Allow one minute of rest in the subject's most comfortable position. Try again; if that fails, then abort the test.

INDICATIONS TO DISCONTINUE TEST: Failure on second attempt; any pain elicited in the performance of this test will result in its termination.

POSITION IN WHICH TO LEAVE SUBJECT: A relaxed supine-lying position.

COMMON ERRORS TO AVOID: Excessive hip rotation during the resistive component of the examination.

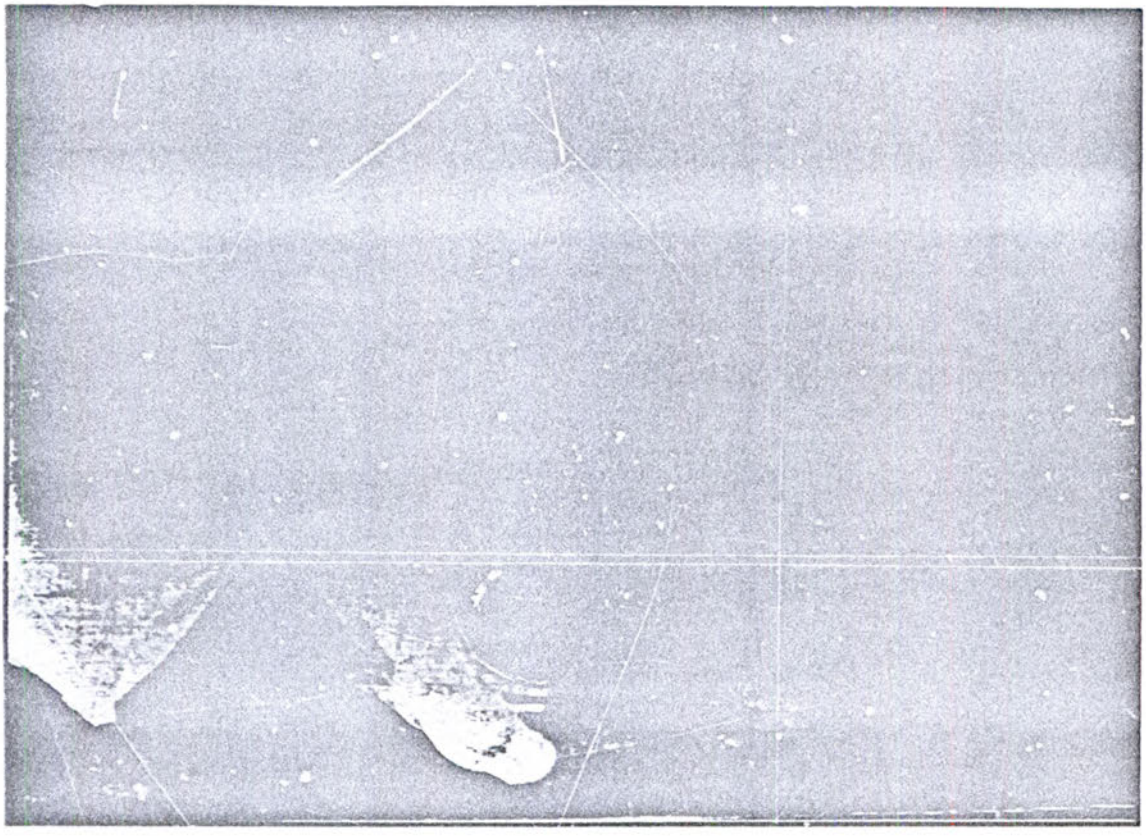

Figure 18. Lower Abdominal Muscle Strength Marginal Reliability

Lower Abdominal Muscle Strength

[MARGINAL RELIABILITY]

DESCRIPTION: Assessment of the strength of the lower abdominal musculature.

INSTRUMENTS REQUIRED: None.

DEFINITION OF TERMS: The term lower is an operational definition, and the specific muscles involved in this test are yet to be determined.

CONTRAINDICATION: Peripheralization of pain with assumption of the starting position of the test.

STARTING POSITION OF SUBJECT: Positioned supine on a table with hands behind the head. The subject's hips are placed in approximately 70 to 90 degrees of flexion, with the soles of the feet resting on the table.

STARTING POSITION OF EXAMINER: At the side of the examining table, with one hand underneath the subject to palpate the lumbar spinous processes.

PROCEDURE: The examiner places one hand underneath the low back of the subject, with the palmar surface against the region of L2 to L5 and the dorsum against the table surface. The examiner instructs the subject to extend the knees, while keeping the lower back flat against the examiner's palpating fingers. From the resting position of 70 to 90 degrees of hip flexion, the knees are fully extended while supported by the examiner. Through the subject's voluntary contraction and passive assistance by the examiner, the subject slowly lowers both legs while keeping the knees extended. The examiner confirms that the low back remains flat against the table by determining whether the spinous processes of L2 to L5 leave the palpating fingers. Two practice tests are performed as the subject is instructed to keep the back flat against the examiner's fingers while the examiner helps the subject lower the legs. On the third trial, the subject lowers the legs without passive assistance from the examiner while the examiner keeps one hand under the legs of the subject and the other hand remains under the lumbar spinous processes. After the test, the subject is allowed to resume a relaxed supine-lying position. The visual angle of hip flexion at the end of the test is recorded on the Recording Form. **Less than 60 percent:** Check here if the lumbar spine lifts off the examiner's palpating fingers within 30 degrees of hip extension (90° to 60°). **Greater than 60 percent:** Check here if the lumbar spine lifts off the examiner's palpating fingers after 30 degrees of hip extension (59° to full extension).

ORDER OF ASSESSMENTS: None.

TIMING: None.

REST PERIODS: None.

WHAT TO DO IF SUBJECT CANNOT ATTAIN OR MAINTAIN POSITION: Allow one minute of rest in the subject's most comfortable position. Try again; if that fails, abort the test.

INDICATIONS TO DISCONTINUE TEST: Failure on second attempt; any pain elicited in the performance of this test will result in its termination; hamstring tightness.

POSITION IN WHICH TO LEAVE SUBJECT: A supine-lying position.

COMMON ERRORS TO AVOID: Subject does not understand what is required by the test or the examiner gives too much support for the lower limbs.

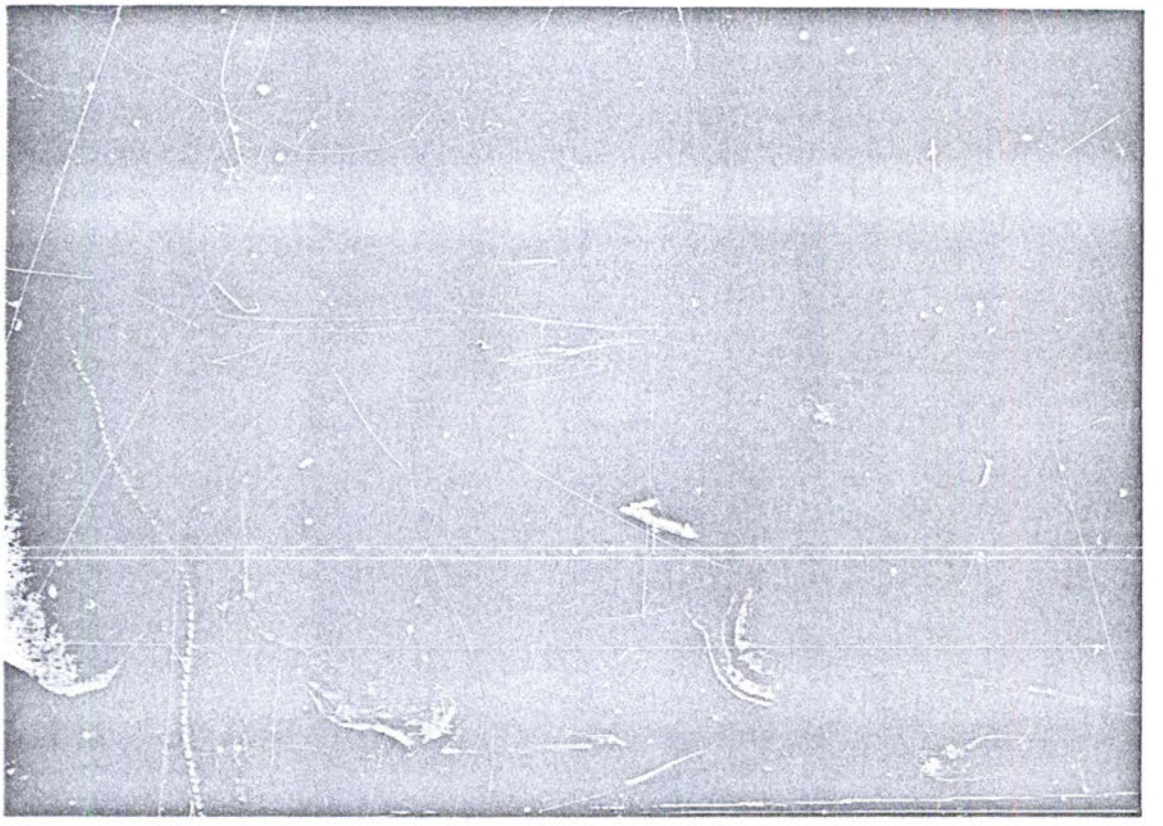

Figure 19. Short Hip Extensor Length Marginal Reliability

Short Hip Extensor Length

[MARGINAL RELIABILITY]

DESCRIPTION: Assessment of the tightness of the short hip extensor (gluteus maximus) muscles.

INSTRUMENTS REQUIRED: None.

DEFINITION OF TERMS: None.

CONTRAINDICATION: Peripheralization of symptoms with assumption of the starting position of the test.

STARTING POSITION OF SUBJECT: Assumes a supine position on the table with both lower extremities extended.

STARTING POSITION OF EXAMINER: Standing at the side of the examining table and by the side being measured, with the palpating fingers on the ischeal tuberosity.

PROCEDURE: With the subject's contralateral leg in extension, the examiner places the leg being measured in flexion at the knee and at the hip. One hand (the palpating hand) is positioned so that the palmer surface is resting on the ischeal tuberosity. The examiner gently pushes the subjects' leg toward the chest with one hand. When the ischeal tuberosity raises off the palpating hand, the examiner estimates the degree of hip flexion. The leg then is lowered, the examiner moves to the other side of the table, and the procedure is repeated on the other leg. Afterward, the subject is allowed to resume a supine-lying position.

The estimated angle of hip flexion is recorded on the Recording Form. The grade is recorded as **normal** when hip flexion of greater than 120 degrees is attained before the ischeal tuberosity lifts off the palpating fingers. A grade of **mild** is recorded for 110 to 119 degrees; a grade of **moderate** is recorded for 100 to 109 degrees; and a grade of **marked** is recorded for less than 99 degrees.

ORDER OF ASSESSMENTS: First the right leg and then the left leg.

TIMING: None.

REST PERIODS: None.

WHAT TO DO IF SUBJECT CANNOT ATTAIN OR MAINTAIN POSITION: Allow one minute of rest in the subject's most comfortable position. Try again; if that fails, abort the test.

INDICATIONS TO DISCONTINUE TEST: Failure on second attempt.

POSITION IN WHICH TO LEAVE SUBJECT: A supine-lying position.

COMMON ERRORS TO AVOID: None.

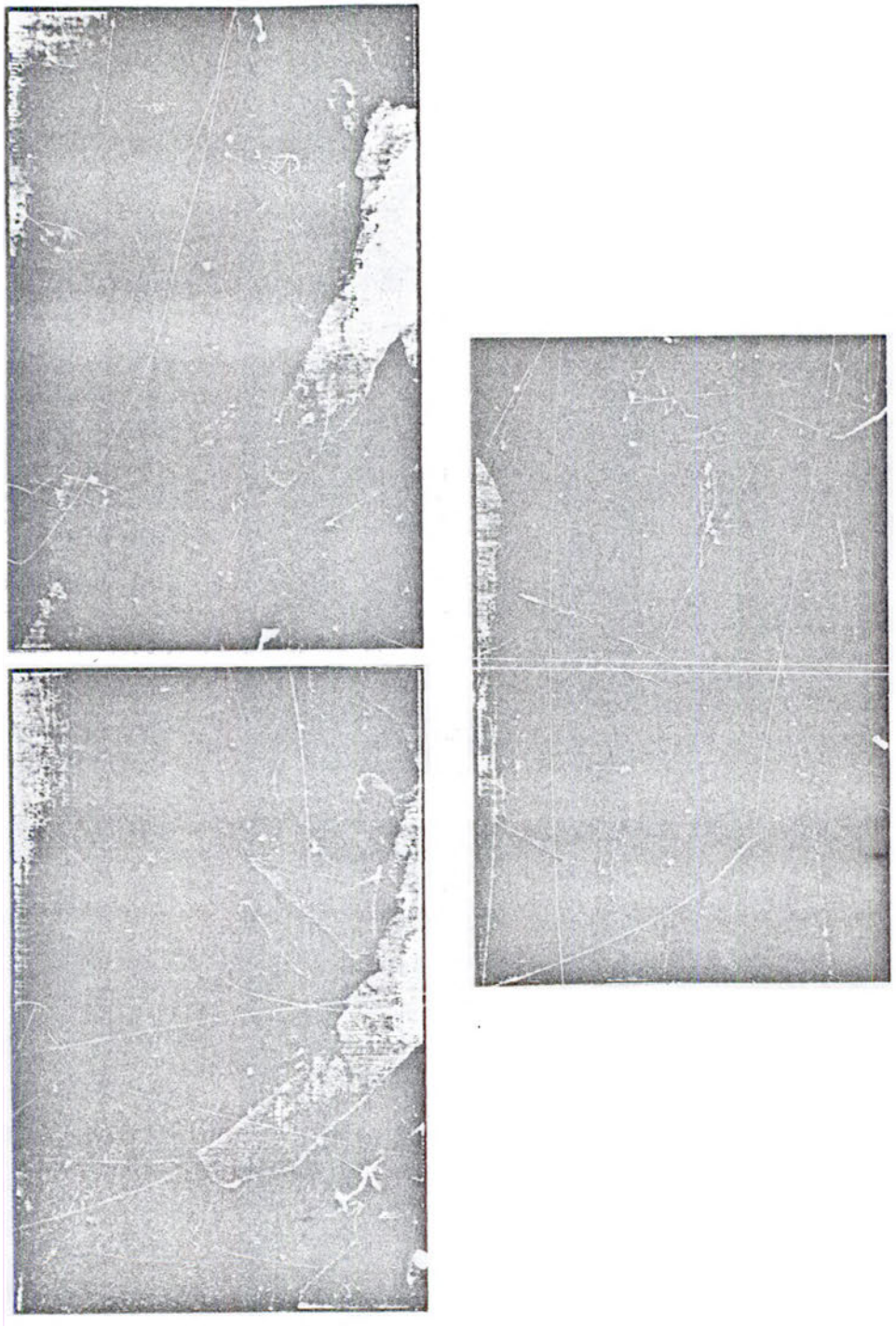

Figure 20. Hip Flexor Length Marginal Reliability

Hip Flexor Length

[MARGINAL RELIABILITY]

DESCRIPTION: Assessment of the tightness of the hip flexor musculature (iliopsoas, rectus femoris, and tensor fascia latae). The test is performed passively and involves differentiating if the tightness is caused by one or a combination of the three hip flexor muscles. The iliopsoas and rectus femoris muscles are differentiated by assessing the amount of hip extension with the knee bent and straight. The tensor fascia latae is assessed by observation of the amount of hip abduction produced when the hip joint is moved passively from an extended to a flexed position or by determination of the presence of external rotation of the tibia on the femur.

INSTRUMENTS REQUIRED: None.

DEFINITION OF TERMS: None.

CONTRAINDICATION: Peripheralization of symptoms with assumption of the starting position of the test.

STARTING POSITION OF SUBJECT: The subject assumes a sitting position with the knees flexed and lower legs hanging over the edge of the table.

STARTING POSITION OF EXAMINER: Standing at the side of the examining table and by the side being measured.

PROCEDURE: As the subject assumes a supine position the non measured knee is brought to the chest, the examiner places one hand underneath the low back with the palmar surface against the region of L2 to L5 and the dorsum against the table surface until the lumbar spine is flat against the table. The examiner instructs the subject to hold the contralateral knee against the chest. The examiner then lowers the measured leg, keeping the knee extended and the hip in neutral abduction. The gravity goniometer is placed on the superior portion of the knee and sets the zero point. The examined limb is brought to 90 degrees of knee flexion and maximum hip flexion. The examined limb is slowly moved into extension. The maximum amount of hip flexion-extension is determined. The examiner records the results on the Recording Form under the area for Iliopsoas Grading. While the hip is in the full extension posture, the knee is flexed passively to approximately 90 degrees to full extension angle with the movement. Record the results on the Recording Form under the area for Rectus Femoris Grading. With the hip flexed, the examiner observes the abduction and rotation of the hip and the external rotation of the tibia as the leg is moved into extension. Record the presence or absence of hip abduction on the Recording Form under the Tensor Fascia Latae Grading. At the completion of the test, the examiner leaves the examined leg with the heel of the foot resting on the edge of the table. The examiner moves to the other side of the table and repeats the procedure.

ORDER OF ASSESSMENTS: First the right side and then the left. Testing order is iliopsoas, rectus femoris, and tensor fascia latae.

TIMING: None.

REST PERIODS: None.

WHAT TO DO IF SUBJECT CANNOT ATTAIN OR MAINTAIN POSITION: Allow one minute of rest in the subject's most comfortable position. Try again; if that fails, abort the test.

INDICATIONS TO DISCONTINUE TEST: Failure on second attempt; any pain elicited in the performance of this test will result in its termination.

POSITION IN WHICH TO LEAVE SUBJECT: A supine-lying position.

COMMON ERRORS TO AVOID: Subject does not maintain the lumbar spine flat against the table or subject does not understand what is required by the test.

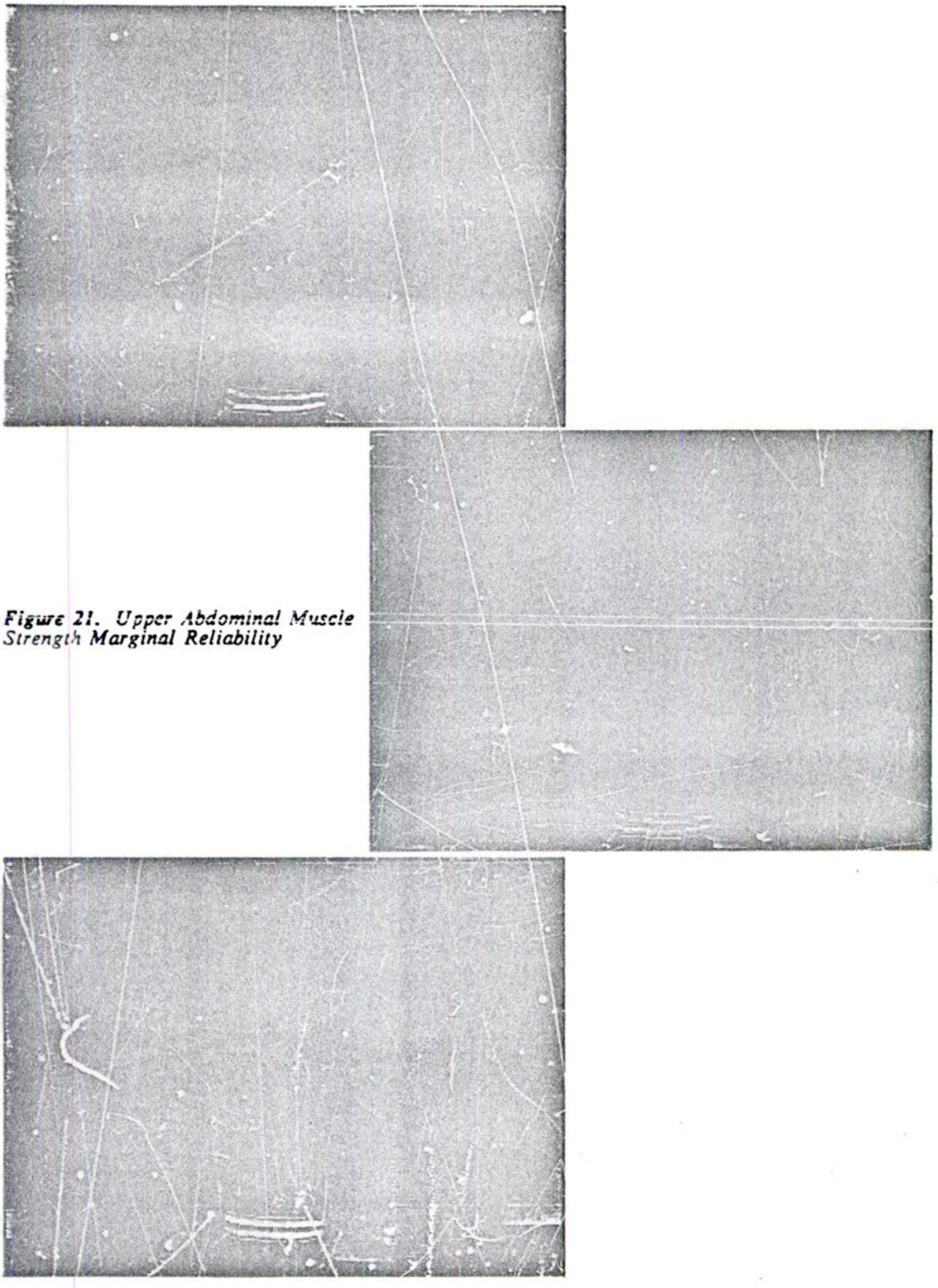

Figure 21. Upper Abdominal Muscle Strength Marginal Reliability

Upper Abdominal Muscle Strength

[MARGINAL RELIABILITY]

DESCRIPTION: Assessment of the strength of the upper abdominal musculature.

INSTRUMENTS REQUIRED: None.

DEFINITION OF TERMS: The term upper is an operational definition, and the specific muscles involved in this test are yet to be determined.

CONTRAINDICATION: Peripheralization of symptoms with assumption of the starting position of the test.

STARTING POSITION OF SUBJECT: Assumes a supine-lying position. For comfort, a pillow may be placed under the subject's knees.

STARTING POSITION OF EXAMINER: Standing at the side of the examining table.

PROCEDURE: The subject positions the hips and knees either straight or in slight flexion and the hands resting at the side of the body. The examiner instructs the subject to flex the head and shoulders up to a point at which the inferior position of the scapulae are off the table. This motion should be accomplished without using any velocity; the subject must lift the head and upper thoracic region from a dead start. The examiner must verify that the hip flexors are not used to sustain the motion by observing the movement of the subject's thighs. If the subject performs the movement without hip motion, ask the subject to fold the arms across the chest and try it again. If the subject completes the movement, then instruct the subject to put arms with hands locked behind the head, try the procedure again. After the procedure(s), allow the subject to resume a comfortable supine-lying position.

The ability to perform the test is recorded on the Recording Form. The following grading system is used: 0: Subject cannot complete the procedure. 1: Subject completes the procedure with arms extended to the sides. 2: Subject completes the procedure with arms folded across the chest. 3: Subject performs the procedure to a point at which the scapulae are off the table with hand locked behind the head.

ORDER OF ASSESSMENTS: First with the arms extended along the sides, second with arms across the chest, and last with hands behind the head.

TIMING: None.

REST PERIODS: None.

WHAT TO DO IF SUBJECT CANNOT ATTAIN OR MAINTAIN POSITION: Allow one minute of rest in the subject's most comfortable position. Try again; if that fails, abort the test.

INDICATIONS TO DISCONTINUE TEST: Failure on second attempt; pain elicited in the performance of this test will result in termination.

POSITION IN WHICH TO LEAVE SUBJECT: A supine-lying position.

COMMON ERRORS TO AVOID: Subject substitutes hip flexor muscles for the muscles being tested.

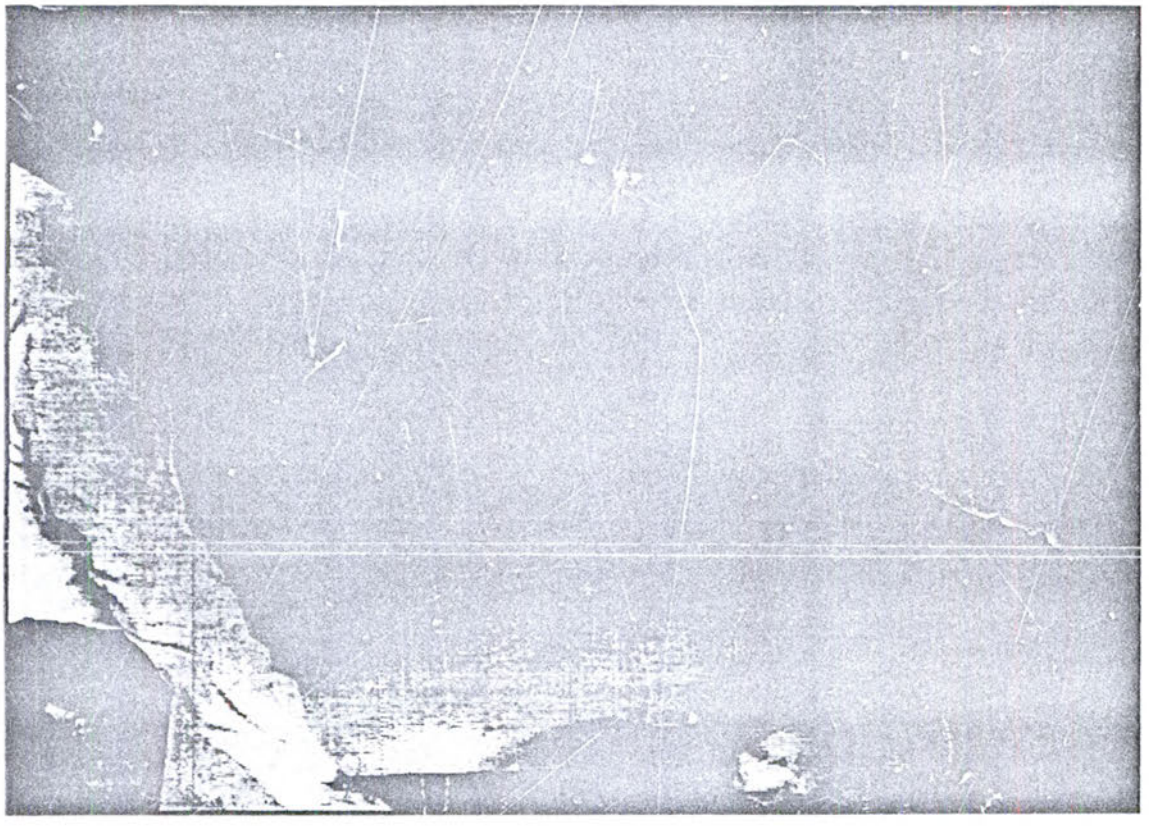

Figure 22. Gluteus Medius Muscle Strength Marginal Reliability

Gluteus Medius Muscle Strength

[MARGINAL RELIABILITY]

DESCRIPTION: Equality of assessment of the bilateral gluteus medius muscles strength.

INSTRUMENTS REQUIRED: Wall marker.

DEFINITION OF TERMS: None.

CONTRAINDICATION: Peripheralization of symptoms with assumption of the starting position of the test.

STARTING POSITION OF SUBJECT: The subject is asked to lie in the side-lying position with the hip to be measured in a superior position. To ensure appropriate stabilization, the examining table is positioned against a wall.

STARTING POSITION OF EXAMINER: Standing and facing the subject.

PROCEDURE: Instruct the subject to place his or her back and buttocks squarely against the wall and to flex the inferior leg at the hip and knee in order to put the sole of the foot in contact with the wall. The examiner passively raises the superior leg upward (abduction) and palpates the superior iliac crest. When the iliac crest starts to rotate, a point is marked on the wall congruent to the subject's lateral malleolus. This procedure establishes the subject's passive hip ROM. Next, instruct the subject to externally rotate and abduct (raise sideward) the superior leg, keeping the knee straight and the heel in contact with the wall. The subject is allowed to practice the test movement two or three times, after which he or she is to perform the test to reach at least the established passive end point. The subject is instructed to repeat the movement actively 10 times. After a series of 10 (or as many as the subject can perform), the subject then is told to turn around so that the opposite leg can be tested in the same manner. After the passive ROM has been determined for the left side, the subject is again asked to practice two or three times and then to lift the leg for a series of 10 times. If the subject is able to raise the leg 10 times on both sides, the examiner asks him or her to assess the relative difficulty of the lifts. The subject then is allowed to resume a supine-lying position.

Record the data on the Recording Form. The grading is as follows: 0: Subject cannot actively attain the passive ROM. 1: Passive ROM level is not attained with subsequent active (10) repetitions. 2: Subject can actively attain the passive ROM level 10 times.

ORDER OF ASSESSMENTS: First the right leg and then the left leg.

TIMING: None.

REST PERIODS: None.

WHAT TO DO IF SUBJECT CANNOT ATTAIN OR MAINTAIN POSITION: Allow one minute of rest in the subject's most comfortable position. Then try again; if that fails, abort the test.

INDICATIONS TO DISCONTINUE TEST: Failure on second attempt.

POSITION IN WHICH TO LEAVE SUBJECT: Supine-lying position.

COMMON ERRORS TO AVOID: Substitution of hip-hiking or subject does not maintain external rotation.

The Instruments

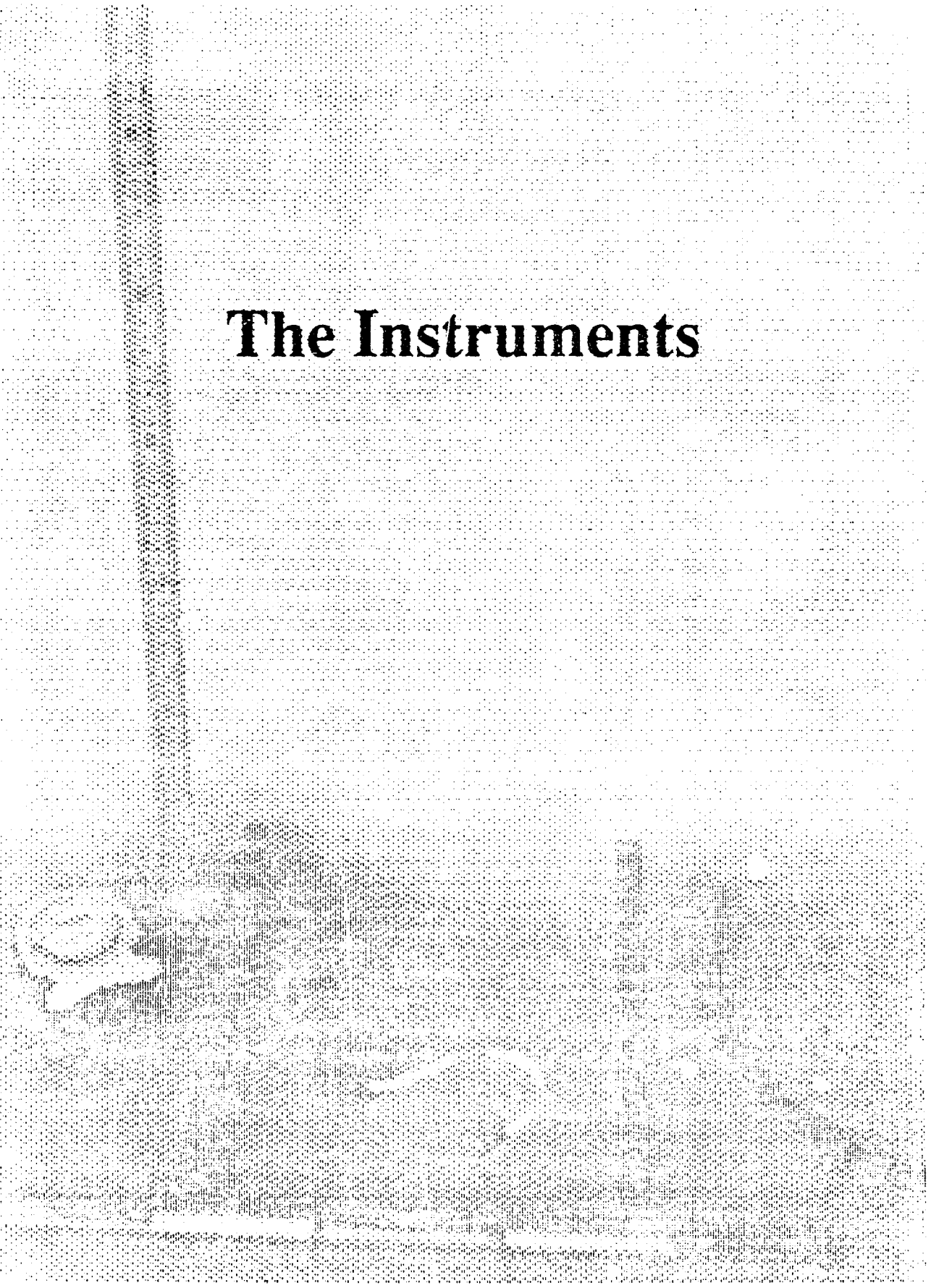

Figure 23. The tools.

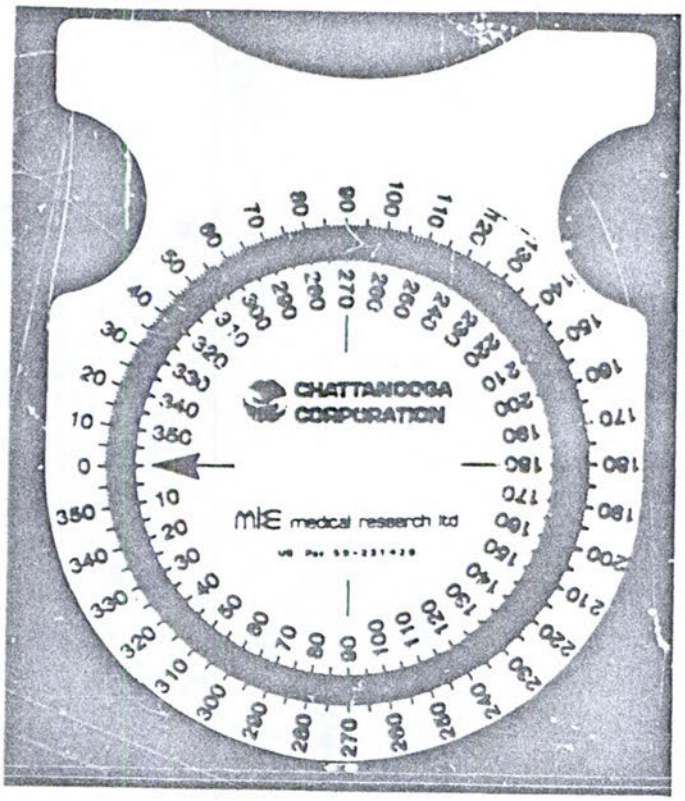

Figure 24. Bubble goniometer.

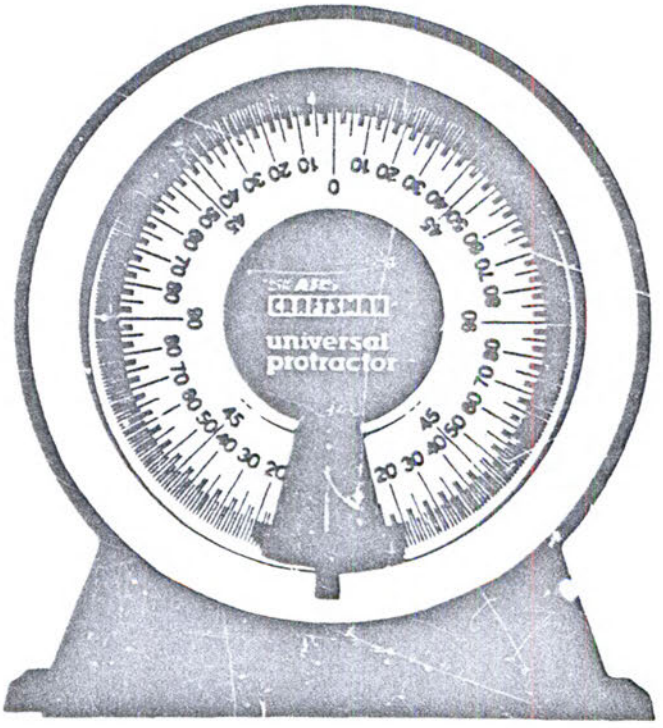

Figure 25. Gravity goniometer.

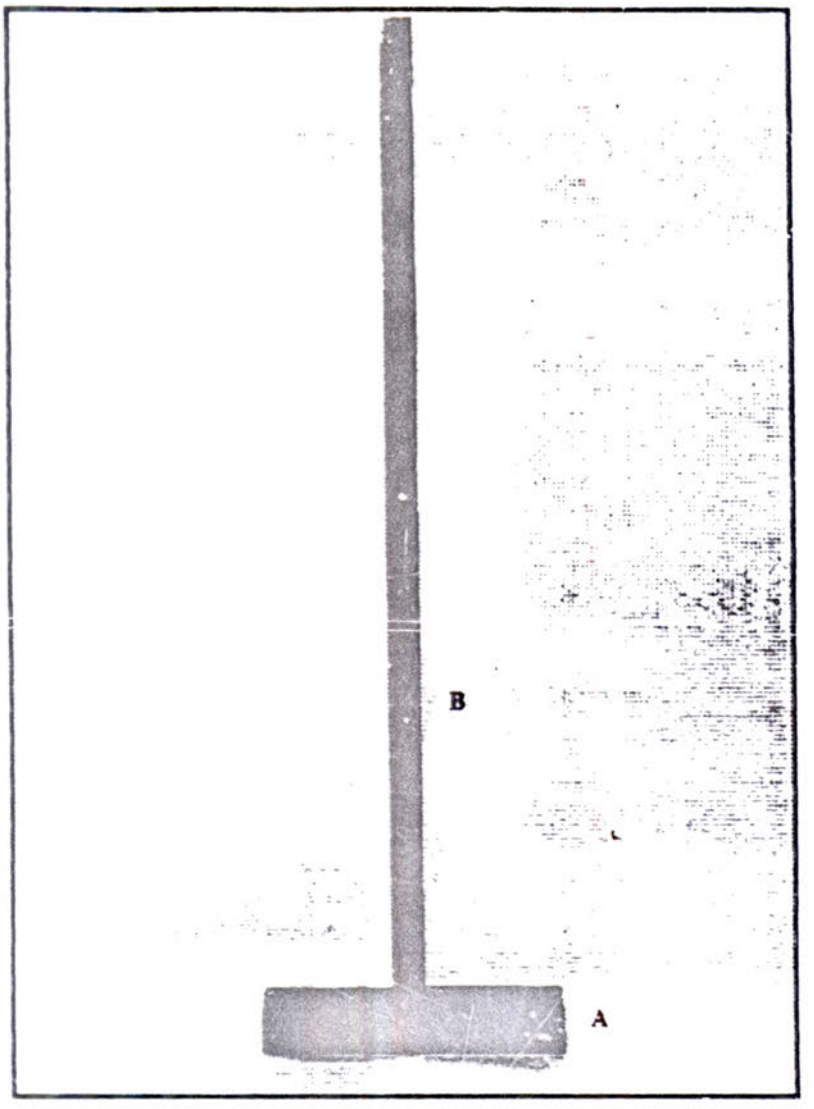

Figure 26. Vertical rule. A is a one foot section of 2-inch by 4-inch board; B is a wooden yardstick.

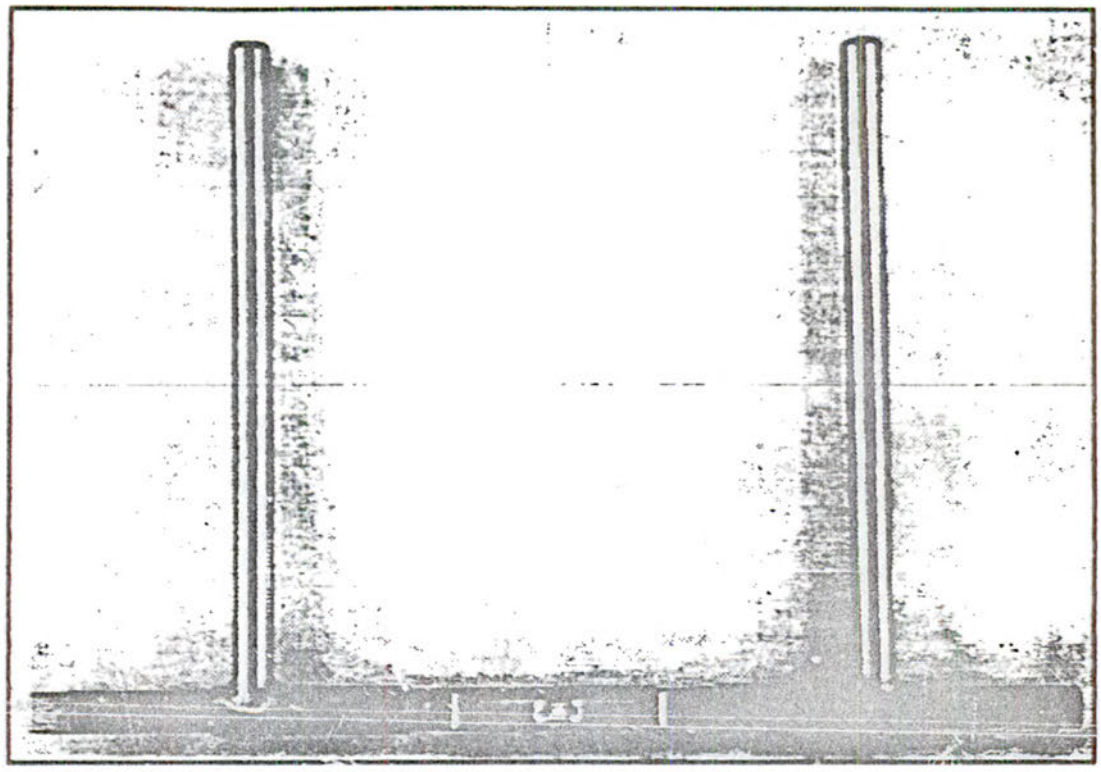

Figure 27. A "crest tester." See text for source and use.

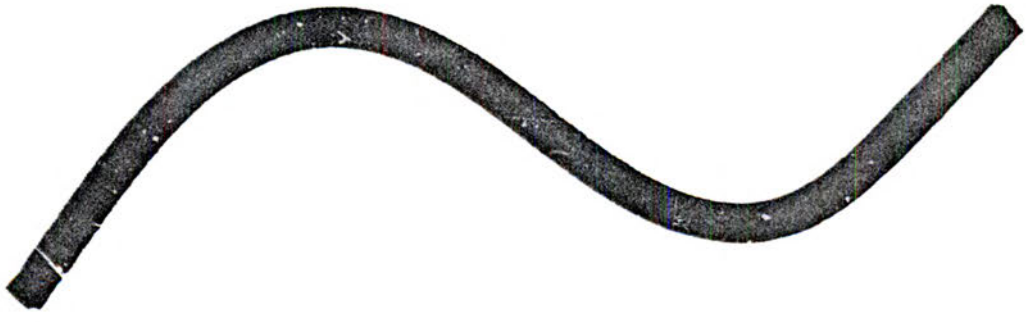

Figure 28. Flexible (Architect's) ruler. In this figure it is shaped as a sine wave.

Figure 29. Transferring the shape of the lumbar spine to the poster board.

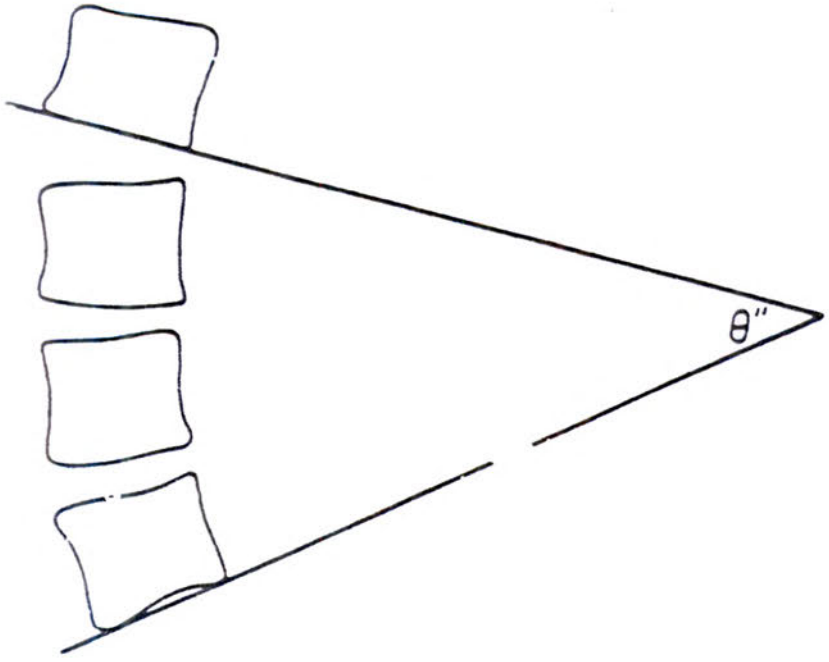

Figure 30. Derivation of the Vertebral Angle θ°.

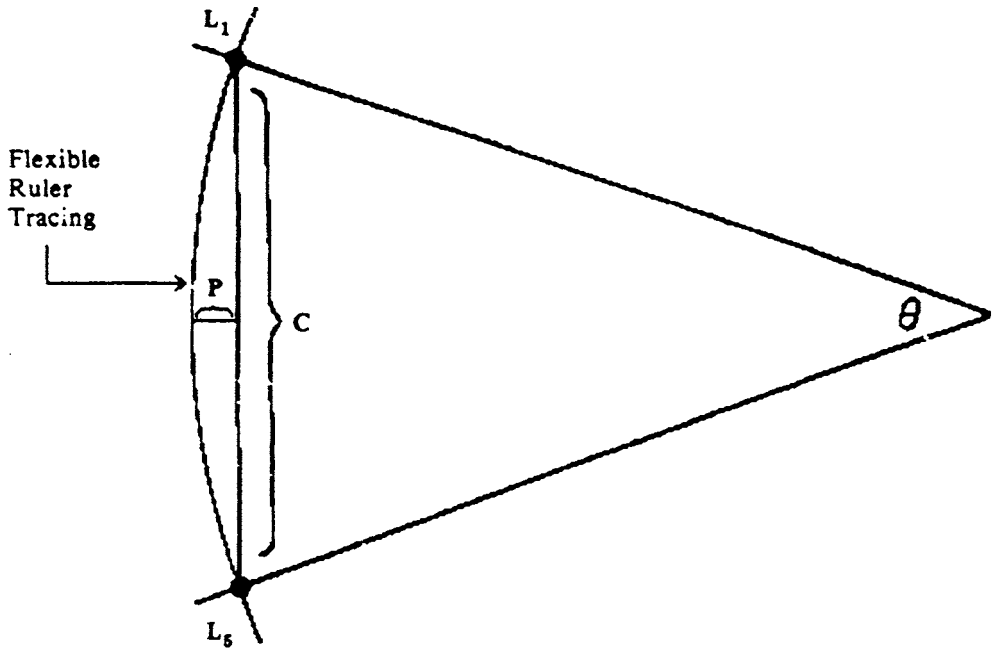

Figure 31. Trigonometric derivation of the angle representing the shape of the lumbar spine.

Procedure to calculate the lumbar lordosis angle from the flexible ruler:

1. Trace the curve from the flexible ruler that touched the skin onto a piece of paper.
2. On the tracing, place a point corresponding to both the L5 and L1 marks (see Figure 30).
3. Connect the two points with a straight line. This line is called the cord. Measure the length of this cord in centimeters. Mark the center of the cord (C).
4. Draw a perpindicular line from the bisected cord to the curve. Measure the distance of this line (P).
5. Apply the formula to determine the angle of lumbar lordosis.

   Lumbar Lordosis angle = $4 \arctan \left(\frac{2P}{C} \right)$

6. You will need a calculator that has "arctan" as one of its functions.

PART 2 - RECORDING FORM

TEST: Lumbar lordosis - flexible ruler - standing

CONTRAINDICATION: Patient cannot attain or maintain the static standing position for a short period or cannot tolerate the necessary pressure involved to conform the ruler to the lumbar spine.

top

anterior posterior

bottom

Standing

Flexible Ruler - Tracing

Standing

Lumbar Lordosis - flexible ruler - standing: _____ degrees

Iliac crest - posterior - standing

High right _____
High left _____
Equal _____
N/A _____
If N/A, give reason:
_____

CONTRAINDICATIONS: Patient cannot attain or maintain the static standing position for a short period.

PSIS - posterior - standing

High right _____
High left _____
Equal _____
N/A _____
If N/A, give reason:
_____

CONTRAINDICATIONS: Patient cannot attain or maintain the static seated position for a short period.

Iliac crest - anterior - standing

High right _____
High left _____
Equal _____
N/A _____
If N/A, give reason:
_____

CONTRAINDICATIONS: Patient cannot attain or maintain the static standing position for a short period.

ASIS - anterior - standing

High right _____
High left _____
Equal _____
N/A _____
If N/A, give reason:
_____

CONTRAINDICATIONS: Patient cannot attain or maintain the static standing position for a short period.

Side bending to the right and to the left and total exertion of motion each way

Right side bending	Vertical ruler:	Start	_____cm
		Finish	_____cm
		Excursion	_____cm
Left side bending	Vertical ruler:	Start	_____cm
		Finish	_____cm
		Excursion	_____cm

CONTRAINDICATION: Patient cannot attain or maintain the static standing position for a short period.

Sitting

Iliac crest - anterior - sitting

High right _____
High left _____
Equal _____
N/A _____
If N/A, give reason:
_____

CONTRAINDICATIONS: Patient cannot attain or maintain the static seated position for a short period.

Iliac crest - posterior - sitting

High right _____
High left _____
Equal _____
N/A _____
If N/A, give reason:
_____

CONTRAINDICATIONS: Patient cannot attain or maintain the static seated position for a short period.

PSIS - posterior - sitting

High right _____
High left _____
Equal _____
N/A _____
If N/A, give reason:
_____

CONTRAINDICATIONS: Patient cannot attain or maintain the static seated position for a short period of time.

Lumbar lordosis-flexible ruler-
relaxed sitting degrees _____ degrees

Lumbar lordosis-flexible ruler-
sustained erect sitting _____ degrees

Lumbar lordosis-flexible ruler-
sustained slouched sitting _____ degrees

TEST: **Lumbar lordosis--flexible ruler--relaxed sitting**

CONTRAINDICATION: Patient cannot attain or maintain the static seated position for a short period of time.

top

anterior posterior

bottom

Flexible ruler - (:n relaxed sitting posture)

TEST: **Lumbar lordosis--flexible ruler--sustained erect sitting.**

CONTRAINDICATION: Peripheralization of symptoms with brief sitting

top

anterior

posterior

bottom

Sustained erect sitting

Flexible ruler

TEST: **Lumbar lordosis--flexible ruler--sustained slouched sitting**

CONTRAINDICATION: Peripheralization of symptoms with brief sitting.

top

anterior

posterior

bottom

Sustained slouched sitting

Flexible ruler

Prone lying

Hip joint rotation range of motion with subject in a prone position

(R) int. rotation _____degrees
(R) ext. rotation _____degrees
(L) int. rotation _____degrees
(L) ext. rotation _____degrees

CONTRAINDICATION: Patient cannot assume a static prone position for a short period.

Sustained extension in prone lying-- press-up-symptom change (maximum 30 seconds)

test contraindicated yes [ ] no [ ]

reason:_____

NOTE: IF THERE IS NO CHANGE IN INTENSITY/LOCATION OF PAIN/PARESTHESIA WITH POSITION, CHECK HERE [ ], AND DO NOT FILL OUT ANY GRID.

a. PAIN

	Before initiation	Symptoms at initiation	Symptoms at termination	Time to onset	After termination
Symbols	O,X	O,X	C,P,Isq I,D,Isq	seconds	Im,W,Isq
right leg					
left leg					

REST PERIOD (up to 60 seconds)

KEY

O: no symptoms
X: symptoms present
C: centralization
P: peripheralization

I: increased
D: decreased
Isq: no change
Im: improved
W: worse

b. PARESTHESIA

	Before initiation	Symptoms at initiation	Symptoms at termination	Time to onset	After termination
Symbols	O,X	O,X	C,P,Isq I,D,Isq	seconds	Im,W,Isq
right leg					
left leg					

REST PERIOD (up to 60 seconds)

c. Summary of status: Im [ ] W [ ] Isq [ ]

KEY

O: no symptoms
X: symptoms present
C: centralization
P: peripheralization

I: increased
D: decreased
Isq: no change
Im: improved
W: worse

CONTRAINDICATION: Peripheralization of symptoms with sustained prone lying.

Supine lying

Single straight leg raising — degrees right _____ degrees left _____

CONTRAINDICATION: Patient cannot assume the starting position.

Double straight leg raising (DSLR — degrees _____

CONTRAINDICATION: Patient cannot assume the starting position of supine lying with hips and knees extended.

Hamstring length

degrees right _____
degrees left _____

CONTRAINDICATION: Peripheralization of pain with assumption of the starting position.

Hip flexor muscle strength
(iliopsoas)

Right-muscle test grade _____
Right stronger _____
Left stronger _____
Symmetrical _____

CONTRAINDICATION: Peripheralization of symptoms with assumption of the starting position of the test.

Lower abdominal muscle strength

Less than 60 percent _____
Greater than 60 percent _____

CONTRAINDICATION: Peripheralization of pain with assumption of the starting position of the test.

Short hip extensor length	Right	Left
Normal (greater than 120 degrees)	____	____
Mild (110 to 119 degrees)	____	____
Moderate (100 to 109 degrees)	____	____
Marked (99 degrees or less)	____	____

CONTRAINDICATION: Peripheralization of symptoms with assumption of the starting position of the test.

Hip flexor length

Iliopsoas

(R)	normal (0-5o)	[ ]	(L)	normal (0-5o)	[ ]
	mild (6-10o)	[ ]		mild (6-10o)	[ ]
	moderate (11-20o)	[ ]		moderate (11-20o)	[ ]
	marked (>21o)	[ ]		marked (>21o)	[ ]

right tighter than left [ ]
left tighter than right [ ]
symmetrical [ ]
cannot do [ ]

Rectus femoris grading

		Right	Left
change in hip flexion/extension	Yes	____	____
	No	____	____

Presence of:

hip abduction (R) yes [ ] no [ ]
(L) yes [ ] no [ ]

right tighter than left [ ]
left tighter than right [ ]
symmetrical [ ]
cannot do [ ]

CONTRAINDICATION: Peripheralization of symptoms with assumption of the starting position of the test.

Upper abdominal muscle strength

	Grade	Check Appropriate Box
Cannot complete	0	[ ]
Complete with arms extended	1	[ ]
Complete with arms across chest	2	[ ]
Complete with arms behind head	3	[ ]

CONTRAINDICATION: Peripheralization of symptoms with assumption of the starting position of the test.

Side Lying

Gluteus medius muscle strength

Right-muscle test grade: 0 1 2
Left-muscle test grade: 0 1 2

Patient perception after 10 repetitions

Right stronger [ ]
Left stronger [ ]
Symmetrical [ ]

CONTRAINDICATION: Peripheralization of pain with assumption of the starting position.

APPENDIXES

APPENDIX A

105 test/measures for low back February, 1984

I. SUBJECTIVE EXAMINATION

A. History

1. Present
2. Present For
3. Symptoms on Onset
4. Precipitating Factor
5. Predisposing Factor
6. Mode of Onset
7. Previous History
8. Past Treatment
9. Activity Level
10. Effect of Activity
11. Special Questions
12. Symptoms Best
13. Condition Has Been
    a) Improving
    b) Static
    c) Becoming Worse
14. Results of X-rays
15. Medications
16. Health Status
17. Other Medical Conditions
18. Weight Change in Past 12 Months
19. Gait
20. Bladder/Bowel Dysfunction
21. Sexual Dysfunction

B. Observation

1. Sitting
2. Standing (Anterior View)
3. Standing (Lateral View)
4. Standing (Posterior View)
5. Rhomberg Test
6. Gait

II.OBJECTIVE EXAMINATION

A. Standing

1.Cervical Flexion Test
2.Heel Walking
3.Toe Walking
4.Squat Test
5.Forward Bending
6.Backward Bending
7.Sidebending
8.Sideg!iding
9.Posterior Translation
10.Posterior Shear
11.Flexion
  1.Single
  2.Sustained
  3.Repeated
12.Extension
  1.Single
  2.Sustained
  3.Repeated
13.Lateral Flexion (R)
  1.Single
  2.Sustained
  3.Repeated
14.Lateral Extension (L)
  1.Single
  2.Sustained
  3.Repeated
15.Vertical Rule Test
16.Flexible Rule Test
  1.Flexion
    a. Thoracic
    b. Lumbar
  2.Extension
    a. Thoracic
    b. Lumbar
17.Shober's Test
18.Shift Correction

B. Sitting

1.Observation - Posterior View
2.Hip Internal Rotation - ROM
3.Hip External Rotation - ROM
4.Quadriceps Strength Test
5.Patellar Reflex
6.Achilles Reflex
7.Extensor Hallucis Strength Test
8.Anterior Tibialis Strength Test
9.Peroneal Strength Test

C. Supine

1.Upper Abdominal Strength Test
2.Lower Abdominal Strength Test
3.Lower Abdominal Strength Test
4.Leg Length
5.Straight Leg Raise Test
6.Well Leg SLR Test
7.Bowstring Test
8.SLR With Ankle Dorsiflexion
9.SLR With Ankle Dorsiflexion and Cervical Flexion
10.Bilateral SLR Test
11.Double Knee To Chest
12.Hip Flexion - ROM
13.Iliopsoas Strength Test
14.Patrick's Test
15.Hip Abduction - ROM
16.Hip Flexor Length
17.Rectus Femoris Length
18.Two Joint Hip Flexor Test
19.Hamstring Strength
20.Hamstring Length
21.Babinski Test
22.Clonus
23.Sensory Test
24.Palpation
25.Peripheral Pulses
26.Thigh Circumference

D. Prone

1.Extension-Sustained
2.Extension-Repeated
3.Reflex Hammer Test
4.Spring Test
5.Sacrum Mobility Test
6.P/A Central Vertebral Pressure
7.Transverse Vertebral Pressure
8.Palpation
9.Sensory Test
10.Gluteus Maximus Strength Test
11.Sign of the Buttock
12.Prone Hip Rotation

E. Sidelying

1.Gluteus Medius Strength Test
2.Iliotibial Band Length Test
3.Segmented Mobility Test

APPENDIX B

85 test/measures listed by research site August, 1985

PART I - Subjective/History - George Washington University

EXAMINATION ITEMS

I. SUBJECTIVE EXAMINATION

A. History

Items 1 through 21

PART II- Kinesiologic - West Virginia University

EXAMINATION ITEMS

I. SUBJECTIVE EXAMINATION

B. Observation

1. Sitting
2. Standing (Lat. View)
3. Standing (Lat. View)
4. Standing (Post View)

II. OBJECTIVE EXAMINATION

A. Standing

4. Squat Test
5. Forward Bending
6. Backward Bending
7. Sidebending
8. Sidegliding

B. Sitting

1. Observation-Post View
2. Hip Internal Rot - ROM
3. Hip External Rot - ROM

C. Supine

4. Leg Length
11. Double Knee to Chest
12. Hip Flexion - ROM
13. Hip Abduction - ROM

PART III – Neurologic - The University of Iowa Hospitals and Clinics

EXAMINATION ITEMS

I. SUBJECTIVE EXAMINATION

B. Observation

5. Rhomberg Test
6. Gait

II. OBJECTIVE EXAMINATION

A. Standing

1 Cervical Flexion Test
2. Heel Walking
3. Toe Walking

B. Sitting

5. Patella Reflex
6. Achilles Reflex

C. Supine

5. Straight Leg Raise Test
6. Well Leg SLR Test
7. Bowstring Test
8. SLR With Ankle Dorsiflex
9. SLR With Ankle Dorsiflex and Cervical Flexion
10. Bilateral SLR
21. Babinski
22. Clonus
23. Sensory Test
24. Cervical Flexion Supine

D. Prone

9. Sensory Test

PART IV – Muscle Strength/Length - Washington University

EXAMINATION ITEMS

II. OBJECTIVE EXAMINATION

B. Sitting

4. Quadriceps Strength Test
7. Ext. Hall Strength Test
8. Ant. Tibialis Strength Test
9. Peroneal Strength Test

C. Supine

1. Upper Abdominal Strength Test
2. Lower Abdominal Strength Test
3. Lower Abdominal Strength Test
13. Iliopsoas Strength test
16. Hip Flexor Length
17. Rectus Femoris Length
18. Two Joint Hip Flexor Test
19. Hamstring Strength
20. Hamstring Length

PART IV – Muscle Strength/Length - Washington University

D. Prone

10. Gluteus Maximus Strength

E. Sidelying

1. Gleuhus Medius Strer gth Test
2. Iliotibial Band Length Test

PART V – Movement Testing - Hayward Physical Therapy

EXAMINATION ITEMS

II. OBJECTIVE EXAMINATION

C. Supine

24. Palpation
25. Peripheral Pulses
    - Flexion in Lying
    - Repeated Flex in Lying

D. Prone

1. Extension - Sustained/Repeated/Single
2. Reflex Hammer Test
3. Spring Test
4. Sacrum Mobility Test
5. P/A Central Vertebral Pressure
6. Transverse Vertebral Pressure
7. Palpation
8. Flexion - Sustained/Repeated/Single

APPENDIX C

List of 69 "Acceptable/Marginal" Tests/Measures - August, 1986

Tests/measures in alphabetical order:

ASIS
Double straight leg raising
Extension in standing with pelvic translocation right and left
Flexible ruler (standing)
Flexible ruler (in relaxed sitting posture)
Gluteus medius strength
Hamstring length
Hip flexor length
Hip flexor strength (iliopsoas)
Iliac crest anterior (standing)
Iliac crest anterior and posterior (sitting)
Iliac crest posterior (standing)
Leg length
Lower abdominal strength
Lumbar lordosis
Medial hip rotation
Positive long sitting (relative change in leg length)
Posterior shear (palpable translocation)
Prone hip rotation
PSIS flexion (standing)
PSIS static (standing)
PSIS static and flexion (sitting)
Repeated extension in lying
Repeated extension in lying with right and left pelvic translocation
Repeated extension in standing
Repeated extension in standing with pelvic translocation right or left
Repeated flexion in lying (kneeling)
Repeated flexion in standing
Repeated pelvic translocation right or left
Right and left pelvic translocation (guided) with ROM comparison
Shift (list) (standing)
Short hip extension length
Side bending (right and left) and gross active ROM
Single extension and flexion in standing and gross active ROM
Single extension in lying
Single flexion in lying (kneeling)
Sitting posture
Spring test sacrum
Squat test
Straight leg raising (SLR)
Sustained erect sitting
Sustained extension in lying, press-up
Sustained extension in lying, prone on elbows

Sustained extension in lying with right and left pelvic translocation, prone on elbows
Sustained extension in standing
Sustained extension in standing with pelvic translocation right and left
Sustained flexion in lying (kneeling)
Sustained flexion in standing
Sustained prone lying
Sustained prone lying with pelvic translocation right and left
Sustained slouched sitting
Upper abdominal strength

APPENDIX D

Tests and Measures not included in low back atlas due to low reliability scores or insufficient distribution of subjects

STANDING

Lumbar Lordosis
Shift (List)
Right side bending: symptom behavior
- Change in intensity of pain
- Change in intensity of paresthesia
- Change in location of pain
- Change in location of paresthesia
- Pain
- Paresthesia
- Point in range: pain
- Point in range: paresthesia
- Summary of status: improved, worse, no change
- Flexible ruler

Left side bending: symptom behavior
- Change in intensity of pain
- Change in intensity of paresthesia
- Change in location of pain
- Change in location of paresthesia
- Pain
- Paresthesia
- Point in range: pain
- Point in range: paresthesia
- Summary of status: improved, worse, no change
- Flexible ruler

Gross active ROM (side bending)

Single extension in standing (EIS)
- Change in intensity of pain
- Change in intensity of paresthesia
- Change in location of pain
- Change in location of paresthesia
- Pain
- Paresthesia
- Point in range: pain
- Point in range: paresthesia
- Summary of status: improved, worse, no change

Single flexion in standing (FIS)
- Change in intensity of pain
- Change in intensity of paresthesia
- Change in location of pain
- Change in location of paresthesia
- Pain
- Paresthesia
- Point in range: pain
- Point in range: paresthesia
- Summary of status: improved, worse, no change

Gross active ROM (flexion - extension)

ROM pattern
- Excessive lumber with restricted pelvic
- Excessive pelvic with restricted lumbar
- Not excessively disproportionate
- Other

Right pelvic translocation (guided)
- Change in intensity of pain
- Change in intensity of paresthesia
- Change in location of pain
- Change in location of paresthesia
- Pain
- Paresthesia
- Point in range: pain
- Point in range: paresthesia
- Summary of status: improved, worse, no change

Left pelvic translocation (guided)
- Change in intensity of pain
- Change in intensity of paresthesia
- Change in location of pain
- Change in location of paresthesia
- Pain
- Paresthesia
- Point in range: pain
- Point in range: paresthesia
- Summary of status: improved, worse, no change

Range of motion (from right to left guided)

Posterior shear (palpable translocation)

Repeated right pelvic translocation
- Pain - grid
- Paresthesia - grid
- ROM - increase, decrease, no change
- Summary of status: improved, worse, no change

Repeated left pelvic translocation
Pain - grid
Paresthesia - grid
ROM - increase, decrease, no change
Summary of status: improved, worse, no change

Repeated extension in standing (REIS)
Pain - grid
Paresthesia - grid
ROM - increase, decrease, no change
Summary of status: improved, worse, no change

Extension in standing (EIS) with pelvic translocation right
Change in intensity of pain: increase, worse, decrease, improve, no change
Change in intensity of paresthesia: increase, worse, decrease, improve, no change
Change in location of pain: peripheralizes, centralizes, no change, abolished, produced
Change in intensity of paresthesia: peripheralizes, centralizes, no change, abolished, produced
Point in range: pain: grid
Point in range: paresthesia: grid
Summary of status: improved, worse, no change

Extension in standing (EIS) with pelvic translocation left
Change in intensity of pain: increase, worse, decrease, improve, no change
Change in intensity of paresthesia: increase, worse, decrease, improve, no change
Change in location of pain: peripheralizes centralizes, no change, abolished, produced
Change in intensity of paresthesia: peripheralizes, centralizes, no change, abolished, produced
Point in range: pain: grid
Point in range: paresthesia: grid
Summary of status: improved, worse, no change

Repeated extension in standing with pelvic translocation right
Pain: grid
Paresthesia: grid
ROM: increase, decrease, no change
Summary of status: improved, worse, no change

Repeated extension in standing with pelvic translocation left
Pain: grid
Paresthesia: grid
ROM: increase, decrease, no change
Summary of status: improve, worse, no change

Repeated flexion in standing (RFIS)
Pain: grid
Paresthesia: grid
ROM: increase, decrease, no change
Summary of status: improve, worse, no change

PSIS (flexion)

Sustained extension in standing (30 seconds)
Pain: grid/rest 60 seconds
Pain status
Paresthesia: grid/rest
Paresthesia status
Flexible ruler
Summary of status

Sustained extension in standing with pelvic translocation right (30 seconds)
Pain: grid/rest 60 seconds
Pain status
Paresthesia: grid/rest 60 seconds
Paresthesia status
Summary of status

Sustained extension in standing with pelvic translocation left (30 seconds)
Pain: grid/rest 60 seconds
Pain status
Paresthesia
Paresthesia status: grid/rest 60 seconds
Summary of status

Sustained flexion in standing (30 seconds)
Pain: grid/rest 60 seconds
Pain status
Paresthesia: grid/rest 60 seconds
Paresthesia status
Schobers test
Flexible ruler
Summary of status

SITTING

PSIS (flexion)
Sitting posture
Lordosis/Kyphosis/Normal

Sustained erect sitting
Pain: grid/rest 60 seconds
Pain status
Paresthesia: grid/rest 60 seconds
Paresthesia status
Flexible ruler
Summary of status

Sustained slouched sitting (maximum 2 minutes): symptom behavior
Pain: grid/rest 60 seconds
Pain status
Paresthesia: grid/rest 60 seconds
Paresthesia status
Accepted (flexible ruler)
Summary of status

PRONE

Sustained prone lying (maximum 2 minutes)
- Flexible ruler
- Pain: grid/rest 60 seconds
- Pain status
- Paresthesia: grid/rest 60 seconds
- Paresthesia status
- Summary of status

Sustained extension in lying, prone on elbows
- Pain: grid/rest 60 seconds
- Pain status
- Paresthesia: grid/rest 60 seconds
- Paresthesia status
- Summary of status

Single extension in lying (EIL)
- Change in intensity of pain
- Change in intensity of paresthesia
- Change in location of pain
- Change in location of paresthesia
- Pain
- Paresthesia
- Point in range: pain/grid
- Point in range: paresthesia/grid
- Summary of status

Repeated extension in lying (10 times)
- Pain: grid
- Pain status
- Paresthesia: grid
- Paresthesia status
- ROM
- Summary of status

Sustained prone lying with pelvic translocation right
- Pain: grid
- Pain status
- Paresthesia: grid
- Paresthesia status
- Summary of status

Sustained prone lying with pelvic translocation left
- Pain: grid
- Pain status
- Paresthesia: grid
- Paresthesia status
- Summary of status

Sustained extension in lying with pelvic translocation right, prone on elbows
- Pain: grid
- Pain status
- Paresthesia: grid
- Paresthesia status
- Summary of status

Sustained extension in lying with pelvic translocation left, prone on elbows
- Pain: grid
- Pain status
- Paresthesia: grid
- Paresthesia status
- Summary of status

Repeated extension in lying with pelvic translocation right
- Pain: grid
- Pain status
- Paresthesia: grid
- Paresthesia status
- Summary of status

Repeated extension in lying with pelvic translocation left
- Pain: grid
- Pain status
- Paresthesia: grid
- Paresthesia status
- Summary of status

Single flexion in lying (FIL) (kneeling)
- Change in intensity of pain
- Change in intensity of paresthesia
- Change in location of pain
- Change in location of paresthesia
- Pain
- Paresthesia
- Point in range: pain: grid
- Point in range: paresthesia: grid
- Summary of status

Repeated flexion in lying (kneeling)
- Pain: grid
- Pain status
- Paresthesia: grid
- Paresthesia status
- Summary of status

Sustained flexion in lying (kneeling)
- Pain: grid
- Pain status
- Paresthesia: grid
- Paresthesia status
- Flexible ruler
- Summary of status

Spring test Sacrum

Supine lying
- Straight leg raising
- Pain behavior right
- Pain behavior left
- Pain on resistance
- Leg length
- Right - Left
- Positive long sitting (relative to change in leg length)

GLOSSARY

GLOSSARY

Abduction - To draw away from the mid-line or away from the axial line of a limb.

Acceptable - (Statistical Signifiance Test) - Statistical technique for determining the probability that the observed or larger differences or associations would occur by chance alone if there is no true difference or association in the larger parent population. To regard as having a certain meaning or to receive officially.

Adduction - To draw toward the mid-line or toward the axial line of a limb.

Anatomic Sites - The location of musculoskeletal structures to be identified during the LBA assessment.

Anterior - Situated in front of or in the forward part of the body, toward the head end of the body or a term used to reference the belly side of the body.

Anthropometric Description - Measurements of the size, weight, and proportions of the human body.

Arctan - A trigonometry term/function used to calculate angle of lumbar lordosis from flexible ruler measurements.

Asymptomatic - Showing or causing no subjective complaints.

Atlas - A collection of tests/measures that include illustrations, information, tables, grids, and textual material.

Bone Landmarks - A readily recognizable anatomic structure used as a point of reference in establishing the location of another structure or in determining measurements.

Centralization - The localization of pain, numbness or tingling toward the low back from the leg or buttock. This change in symptoms is in response to the activity of position associated with a test/measure.

Classification Scheme - A systematic, organized framework for evaluating, identifying, and categorizing groups of musculoskeletal injury sign and symptoms which lead to treatment interventions.

Clinical Validity - The extent to which a study or test measures what it purports to measure when that test or measure is applied to the actual assessment of subjects/patients.

Coincident - Occupying the same space or time

Computer Compatible - The data from the Low Back Atlas may be coded and subsequently stored by a computer program.

Concurrent Validity - Positive agreement or convergence of opinion about the validity of a test/measure and its ability to be measured.

Contraindications - A situation in which inherent factors, action or propositions are inconsistent or contrary to one another. Refers to a subject response leading to termination of a test/measure.

Contralateral - Occuring on or acting in conjunction with similar parts on an opposite side.

Cord - A trigonometry term describing a segment of a line from a point on a circle to another point on the same circle without passing through the circles cneter.

Crest Tester - The instrument used to assess the equality of the iliac crest heights. It is used in select standing and sitting tests/measures.

Criteria - A standard on which a judgement or decision may be based.

Decreased - To become progressively less in intensity; to reduce or lower the amount of pain associated with a test/measure.

Delimiting - A character that marks the beginning or end of a unit of data; to fix or define the boundary.

Deviation - A turning away from the regular standard or accepted course. Movement away from normal axis and range of motion.

Diagnostic - The art of distinguishing one injury or disease from another; determination of the nature of an injury or disease.

Discal - The circular or rounded flat plate between the vertebral body of the axial spine. (Refers to pain caused by deformation of the disk.)

Dominant Eye - The commanding and controlling eye used to determine position and height equality measurements during the LBA Assessment.

Dysfunction - Impaired, disturbed or abnormal functioning.

Erect - Standing or sitting upright; characterized by firm or rigid straightness in body position.

Excursion - The distance traversed.

Excursion Measurements - The distance traversed from the beginning to end of the side-bending lumbar range of motion as measured with the vertical ruler.

Expert - An individual experienced in performing the test/measure; one with demonstrated special skills or knowledge which has been validated and therefore represents a mastery of a particular subject.

Extension - The movement by which two ends of any joint part are drawn away from each other. A movement which brings a limb into or toward a straight condition.

External Rotation - The lateral or outward turning of an extremity about its long axis.

Flexibility - A state characterized by a ready capability to adapt to new, different or changing alignments or positions of the spine.

Flexible Ruler - A pliable metal band encased in a supple nonelastic plastic covering which is used for measuring lumbar spine range of motion.

Flexion - The movement by which two ends of any joint are drwan toward each other. A movement whcih brings a limb into or toward a bent condition.

Goniometric Measurement - Determination of extremity and axial spine range of motion using a goniometer (instrument used to measure angles).

Gravity Goniometer - An instrument for measuring angles. Orientation of the measuring dial is influenced and governed by the forces of gravity. All angles measured are referenced to gravity.

Grid - A chart with horizontal and prependicular lines used for recording response to tests/measures.

Improved - To advance or progess in a desireable direction. A positive response to a test/measure.

Increased - To become progressively greater; to grow in intensity as in pain, numbness or tingling as a response to a test/measure.

Indications - A sign or circumstance which points to c shows the cause, pathology or treatment of an injury; that which serves as a guide or warning.

Inferior - Situated below or directed downward.

Internal Derangement - Intra-articular loose fragment of cartilage or bone which causes a localized block of joint movement and a painful loss of range of motion.

Internal Rotation - The medial or inward turning of an extremity about its long axis.

Interspinous Space - Area between the vertebral spinous processes.

Intervention - To occur, fall or come between points of time or events; to come in or between by way of modification.

Ipsilateral - Situated on or affecting the same side.

Kinesiologic - Pertaining to the study of motion of the human body. The sum of what is known regarding human motion.

Lateral - Denoting a position further from the midline of the body.

Length - An expression of a muscle characteristic describing the most compact or shortened to the extreme elongated demension of the muscle. Ability of muscle to allow the joint structure to move through a full, unrestricted range of motion.

Lordotic - Pertaining to or characterized by lordosis.

Lumbar Lordosis - The anterior concavity (hollow) in the curvature of the lumbar spine as viewed from the side.

Marginal - On the border, edge or the outermost limits. Occupying the borderline

Medial - Pertaining to the mid-line of the body.

Mobility - A state characterized by free flowing movement.

Movement Testing - Observation and measurement of trunk and limb motion.

Muscle Strength/Length - The ability of muscle to perform a sustained, powerful movement through the full range of motion.

Musculoskeletal Injuries - Damage, inflammation or impairment of the muscle, tendon, ligament or bony structures of the body.

Neurologic - Pertaining to the nervous system.

Neutral Position - Resting position of the body; alignment of the body in the mid-range, resting position.

Novice - An individual inexperienced in performing the tests/measures.

Objective - A sign that is perceptible to the examiner and external senses; a measureable sign.

Ordered Tests - The arrangement of the tests/measures so that the outcome of each test/measure does not affect or effect subsequent test/measure results.

Pain Behavior - Action or reaction of the subject in response to a more or less localized sensation of discomfort, distress or agony which results from the stimulation of specialized nerve endings. Subject pain response may be no change, increased or decreased.

Palmar Surface - Pertaining to the palm or flexor surface of the hand or the hollow of the hand.

Palpating - The art of feeling with the fingers; the application of the fingers with light pressure to the surface of the body for the purpose of identifying bony landmarks and anatomic structures.

Paresthesia - Abnormal sensation such as burning, prickling or crawling.

Passive Range of Motion Minimum/maximium bending and straightening of a joint as performed by external forces or means. The subject/patient does not actively participate in performing the motion.

Performance Criteria - The ability to execute and fullfil a standard on which a judgement or decision may be based.

Peripheralization - Response to a test/measure that causes pain, numbness or tingling to move away from the low back into the buttock or leg.

Perpendicular - Being at right angles (90 degrees) to a given line or plane.

Posterior - Situated in back of or in the back part of, or affecting the back part of the structure; a term used in reference to the back or dorsal surface of the body.

Prone - Lying face downward.

Protocol - The original notes made on an experiment or test/measure.

Range of Motion (ROM) -The space or extent included, covered or used. The difference between the upper and lower limits. The minimum and maximum available joint angles.

Relaxed Sitting - Posture achieved by lengthening and relative inactivity of paraspinal muscles usually resulting in flattening of the lumbar lordosis.

Reliable - Giving the same results on successive trials.

Reproducibility - The ability of a test/measure to produce consistent results when independently repeated and interpreted under nearly identical circumstances.

Sagittal Plane - Situated in the direction of an anteroposterior plane or section parallel to the median plane of the body.

Sensitivity - The proportion of those tests/measures with positive results as measured by the gold standard.

Signs - An indication of the existance of something; any objective evidence of an injury. Such evidence of a problem is perceptible to the examiner.

Spinal Dysfunction - Impaired, disturbed or abnormal functioning of spinal segments due to pain, internal derangement, etc. resulting in the loss of range of motion.

Static - At rest; in equilibrium; not in motion; not dynamic.

Strength - The quality or state of being strong; a capacity for exertion of endurance; power to resist force.

Strong - Possesing or exhibiting physical power or force; having or marked by great physical power.

Subjective - Pertaining to or perceived only by the effected individual; not perceptible to the senses of the examiner.

Substitute - The act of putting one thing in the place of another. Using one muscle activity in place of another to avoid pain or weakness.

Superior - Situated above or directed upward; a term used in reference to a structure occupying a position nearer the top.

Supine - Lying on the back, face upward.

Sustained - To hold up; prolonged; maintained.

Sustained Erect Sitting - Prolonged, upright sitting posture to achieve and maintain increased lumbar lordosis.

Sustained Extension in Prone Lying - Prolonged, prone lying posture to achieve and maintain increased lumbar lordosis in a relaxed, supported position.

Sustained Slouched Sitting - Prolonged, relaxed sitting posture to achieve and maintain decreased lumbar lordosis or increased lumbar kyphosis (rounded); an indirect measurement of lumbar flexion.

Symmetrical - The similar arrangement in form and relationship of parts around a common axis, or on each side of a plane of the body.

Symptomatic - Pertaining to or of the nature of a symptom.

Symptom - Any subjective evidence of injury or a patients condition. Such evidence as perceived by the patient as a change in their condition indicative of some bodily or mental state.

Transposing - The art of tracing the outline of the flexible ruler onto paper so measurements of lumbar lordosis angle may be calculated. The transfer of information from one place or period to another.

Validity - The extent to which a study or test measures what it purports to measure.

Vertical Ruler - Test/measure equipment used to measure side-bending excursion and lumbar lateral flexion (side-bending) range of motion. It is constructed by attaching a one meter long ruler to a wood base.

Weak - Applies to deficiency or inferiority in strength or power.

Worse - Applies to a test/measure outcome that causes the subject's pain to increase. Also implies an unfavorable or unpleasant outcome to a test/measure.