LOW BACK ATLAS OF STANDARDIZED TESTS/MEASURES

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16. Abstract (Limit: 200 words) This Atlas provided a standardized list of selected, commonly used tests and measurements which may be helpful to researchers conducting scientific and clinical studies related to low back musculoskeletal injuries. Each of the 23/tests/measures was described, including purpose, instruments required, contraindications, starting position of the patient, starting position of the examiner, procedure, order of assessments, timing, rest periods, actions to take if a patient cannot attain or maintain the position, indications to discontinue the test, position in which to leave the patient, and common errors. A photograph of each test/measure was provided. Instruments used for these tests/measures were described. A recording form was provided to assist in obtaining reproducible results. A glossary of terms was included.

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PREAMBLE

The Low Back Atlas (LBA) has been developed to provide a partial list of standardized tests/measures for use by health care practitioners in the medical and the industrial communities when assessing low back musculoskeletal injuries. The LBA obviously does not include all the possible tests/measures that could be used in this setting; however, it does include many that are commonly used. 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 Atlas of Tests/Measures may serve as a foundation and starting point for a larger, comprehensive low back evaluation system. The future development of such a system for assessing low back musculoskeletal injuries in the workplace depends upon clinical validation, as well as, the development of a classification and/or categorization system.

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. There are 23 tests/measures reported in this publication.

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:

- No claim is made regarding the LBA tests, nor the many tests not included in this Atlas.
- 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.
- As with any test, each facility should determine its own level of reliability for its examiners using the same instructional procedures noted in Part 1 of this standardized list of tests/measures.
- The tests/measures reported in this document have been carefully ordered in an attempt to insure that one test does not react to, or adversely affect other tests/measures. No studies have been done to assess the LBA test order. However, the examiner using this protocol should consider performing these tests/measures in the order provided. ***Reordering the test sequence may adversely affect the outcome measures of the respective tests.***

- The tests/measures reported in this document have not been examined for discriminate validity (i.e., sensitivity/specificity).

- 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 clinical management, clinical utility, risk factor analysis, intervention strategies or prevention programs. Further research is needed to evaluate and develop each of these areas.***

Summary

The Low Back Atlas provides a standardized list of selected, commonly used tests/measures which may be used by researchers to conduct scientific and clinical studies related to low back musculoskeletal injuries. A common language to facilitate an effective exchange of research information is provided by the Low Back Atlas.

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INTRODUCTION

The Low Back Atlas is divided into two parts and a glossary:

Part 1 contains a summary of LBA tests and measures, descriptions of the tests/measures, and a description of the instruments required to perform the tests/measures. The descriptions of the tests/measures include both a verbal description and a still photograph of each test/measure, which is standardized according to: purpose, instrument(s) required, definition of terms, contraindication(s), starting position of subject, starting position of examiner, procedure, order of assessments, timing, rest periods, what to do if the subject cannot attain or maintain position, indications to discontinue the test, position in which to leave the subject, and common errors to avoid. The instrument section provides a description, and picture for each piece of equipment used in the performance of the test/measure.

Note: The use of instruments as depicted in this manual does not constitute endorsement by the National Institute for Occupational Safety and Health.

Part 2 contains the Low Back Atlas recording form. This form has been carefully developed to obtain reproducible results. The various grids and marking areas are important and should be followed.

A ***Glossary*** of terms completes the document. The glossary provides functional definitions, descriptions, and appropriate use of the terms.

PART 1 - TESTS/MEASURES DESCRIPTION

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Summary of LBA Tests/Measures

TEST

Standing

Contour of the Lumbar Curve-Flexible Ruler-Standing

Iliac Crest Posterior-Standing

Posterior Superior Iliac Spine (PSIS)-Posterior-Standing

Iliac Crest-Anterior-Standing

Anterior Superior Iliac Spine (ASIS)-Anterior-Standing

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

Sitting

Iliac Crest-Anterior-Sitting

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Contour of the Lumbar Curve-Flexible Ruler-Relaxed Sitting

Contour of the Lumbar Curve-Flexible Ruler-Sustained Erect Sitting

Contour of the Lumbar Curve-Flexible Ruler-Sustained Slouched Sitting

Summary of LBA Tests/Measures *(continued)*

Prone

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

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

Supine

Passive Single Straight Leg Raising

Passive Double Straight Leg Raising

Hamstring Length and Associated Lumbar Flexibility

Hip Flexor Muscle Group Strength

Lower Abdominal Muscle Strength

Gluteus Maximus Length and Associated Lumbar Flexibility

Hip Flexor Length

Upper Abdominal Muscle Strength

Side-lying

Dynamic Hip Abduction

The Tests

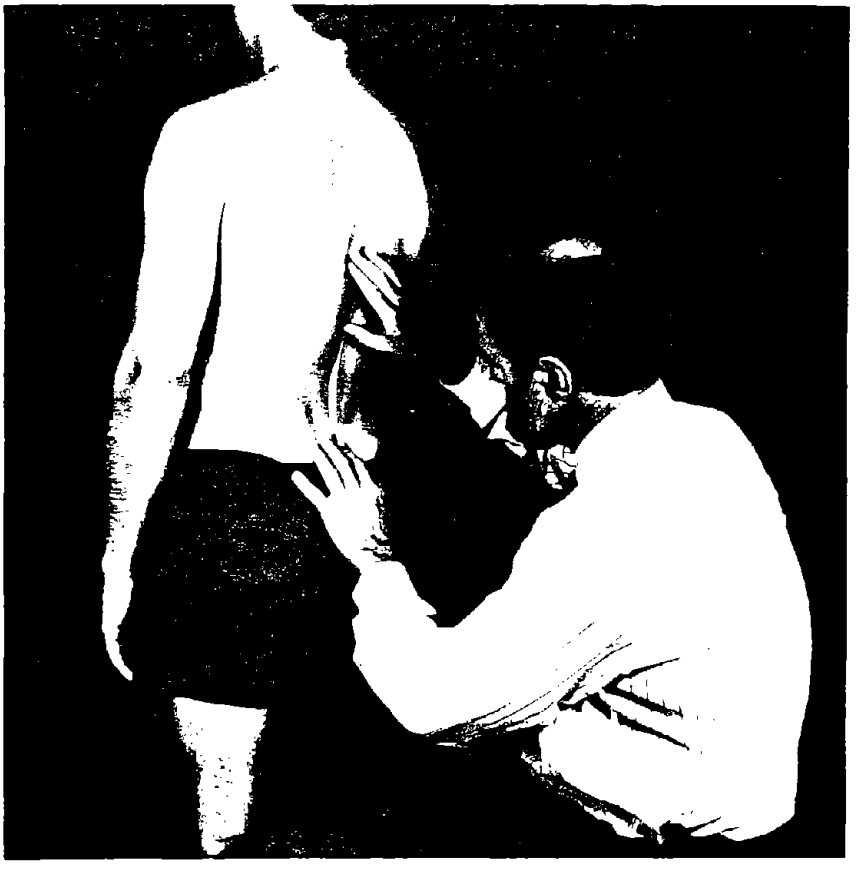


Figure 1. *Contour of the Lumbar Curve-- Flexible Ruler -- Standing*

Contour of the Lumbar Curve -- Flexible Ruler -- Standing

PURPOSE: Measurement of the lumbar spine contour in the sagittal plane using a flexible ruler, with subject in a relaxed standing position.

INSTRUMENTS REQUIRED: Flexible ruler, felt tip pen, and marking dots.

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, weight borne evenly on both feet, and heels six inches apart.

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

ORDER OF ASSESSMENTS: None.

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 (avoiding excessive tissue roll) 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 finger of the examiner's hand puts pressure over the spinous process at that level (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 flexible ruler lined up with the lower marking dot. 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. 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 to the pencil mark. The degree angle of lumbar curve is calculated (pp 62-64). The degree angle is recorded on the Recording Form.

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: Symptoms increase or peripheralize.

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

COMMON ERRORS TO AVOID: Miscounting vertebral 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

PURPOSE: Assessment of the levels of the iliac crests using 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 , weight borne evenly on both feet, and heels six inches apart.

STARTING POSITION OF EXAMINER: Seated on a stool behind the subject.

ORDER OF ASSESSMENTS: None.

PROCEDURE: The examiner spreads the bars of the crest tester. Each of the bars is 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, on the left, or that the crests are equal.

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 contact with the iliac crests. Failing to maintain correct starting position.

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

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

PURPOSE: 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 at the sides, knees straight, weight borne evenly on both feet, and heels six inches apart.

STARTING POSITION OF EXAMINER: Seated on a stool behind the subject.

ORDER OF ASSESSMENTS: None.

PROCEDURE: The examiner's thumbs are placed beneath the anatomic area where the PSISs are located. The thumbs are then 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.

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: Failing to maintain correct starting position.

Figure 4. *Iliac Crest -- Anterior -- Standing*

Iliac Crest -- Anterior -- Standing

PURPOSE: Assessment of the levels of the iliac crests using 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, weight borne evenly on both feet, and heels six inches apart.

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

ORDER OF ASSESSMENTS: None.

PROCEDURE: The examiner spreads the bars of the crest tester. Each of the bars 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, on the left or that the crests are equal.

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: Failing to maintain correct starting position.

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

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

PURPOSE: 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, weight borne evenly on both feet, and heels six inches apart.

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

PROCEDURE: The examiner's thumbs are placed 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, with care taken not to trap tissue superior to 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.

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: Failing to maintain correct starting position.

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

PURPOSE: Measurement, in centimeters, of the range of motion of side bending of the lumbar spine by the use of a vertical ruler starting with subject in an erect standing posture.

INSTRUMENTS REQUIRED: Vertical ruler.

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, weight borne evenly on both feet, and heels six inches apart.

STARTING POSITION OF EXAMINER: Seated on a stool behind the subject.

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

PROCEDURE: The base of the vertical ruler is placed against the outer border of the subject's right foot so that the long finger of the subject's right 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.

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: Since the following tests will be done sitting, 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 numbers on the vertical ruler (eg, transposing a 6 or a 9 while the ruler is positioned opposite from the examiner).

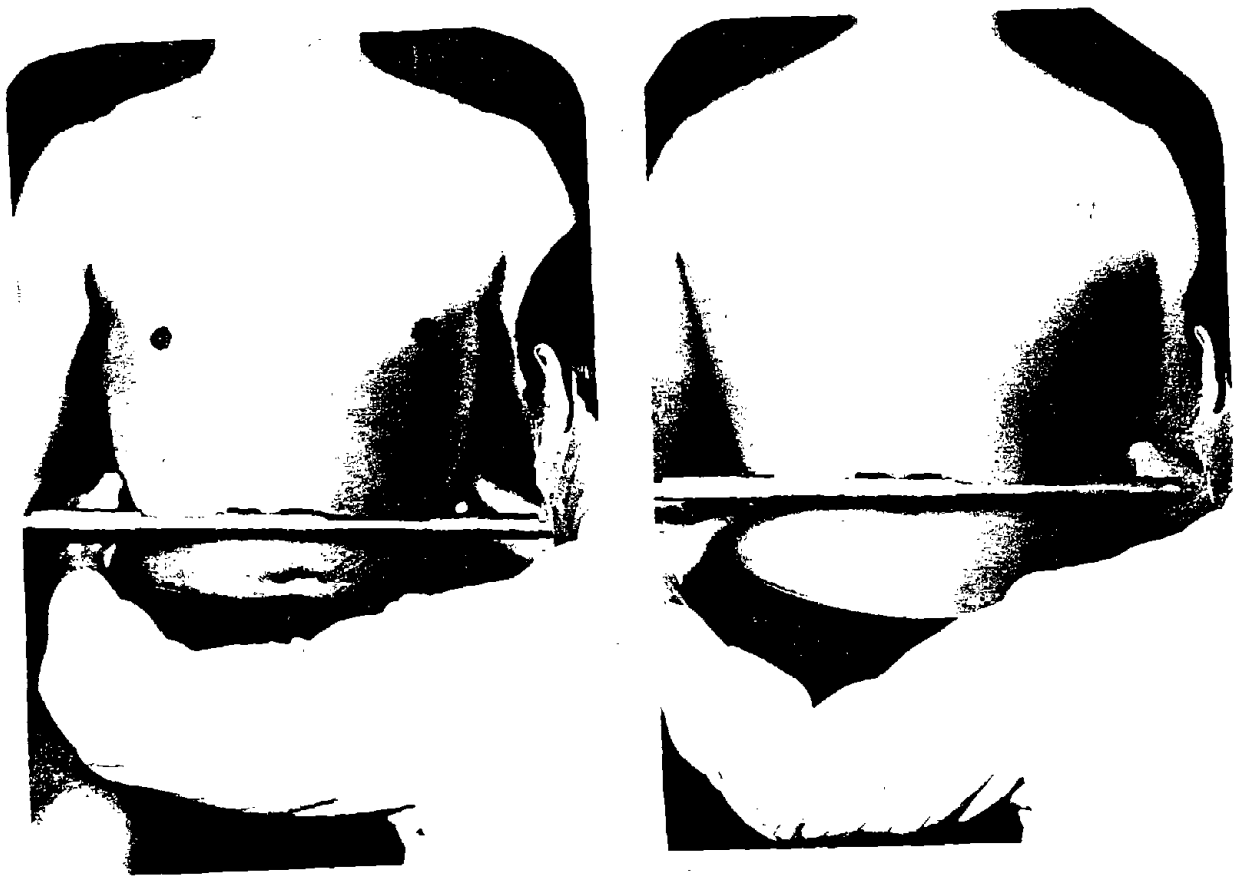


Figure 7. Iliac Crest -- Anterior and Posterior -- Sitting

Iliac Crest -- Anterior and Posterior -- Sitting

PURPOSE: Assessment of the levels of the iliac crests using 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 on a level table with knees flexed.

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

ORDER OF ASSESSMENTS: Observe the anterior crest levels first, followed by the posterior crest levels.

PROCEDURE: The examiner spreads the bars of the crest tester. Each of the bars 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, on the left, or that the crests are equal. Repeat the entire process from the back of the subject.

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: Not having the crest tester bars in symmetrical contact with the iliac crests. Failing to maintain correct starting position.

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

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

PURPOSE: Assessment of the levels of the PSISs visually, with subject at rest in a 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.

STARTING POSITION OF EXAMINER: Seated on a stool behind the subject.

ORDER OF ASSESSMENTS: None.

PROCEDURE: The examiner's thumbs are placed 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.

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: Upon failure to complete the test on the second attempt, indicate N/A on the Recording Form, and explain the reason for the failure.

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

COMMON ERRORS TO AVOID: Failing to maintain correct starting position.

Figure 9. *Contour of the Lumbar Curve -- Flexible Ruler -- Relaxed Sitting*

Contour of the Lumbar Curve -- Flexible Ruler -- Relaxed Sitting

PURPOSE: Measurement of the lumbar spine contour in the sagittal plane using a flexible ruler.

INSTRUMENTS REQUIRED: Flexible ruler, felt tip pen, and marking dots.

DEFINITION OF TERMS: Peripheralization.

CONTRAINDICATIONS: Peripheralization of symptoms with brief sitting or cannot assume a 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 comfortable seated position on a level table with knees flexed, weight borne evenly on both buttocks.

STARTING POSITION OF EXAMINER: Seated on a stool behind the subject.

ORDER OF ASSESSMENTS: None.

PROCEDURE: The examiner's thumbs are placed beneath anatomic area where the posterior superior iliac spines (PSISs) are located. The thumbs then are slid upward (avoid excessive tissue roll) 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 finger of the examiner's hand puts pressure over the spinous process at that level (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. 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. 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 to the pencil mark. The degree angle of lumbar curve is calculated (pp 62-64). The degree angle is recorded on the Recording Form.

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: Symptoms increase, or peripheralize.

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

COMMON ERRORS TO AVOID: Miscounting vertebral 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, and failing to maintain correct starting position.

Figure 10. Contour of the Lumbar Curve -- Flexible Ruler -- Sustained Erect Sitting

Contour of the Lumbar Curve -- Flexible Ruler -- Sustained Erect Sitting

PURPOSE: Measurement of the lumbar spine contour in the sagittal plane using a flexible ruler, with the subject in a sustained erect sitting position.

INSTRUMENTS REQUIRED: Stopwatch, flexible ruler, felt tip pen, and marking dots.

DEFINITION OF TERMS: Peripheralization.

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 on a level table with the knees flexed, weight borne evenly on both buttocks.

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

ORDER OF ASSESSMENTS: None.

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's thumbs are placed beneath the anatomic area where the posterior superior iliac spines (PSISs) are located. The thumbs then are slid upward (avoid excessive tissue roll) 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 finger of the examiner's hand puts pressure over the spinous process at that level (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. 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. 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 to the pencil mark. The degree angle of lumbar curve is calculated (pp 62-64). The degree angle is recorded on the Recording Form.

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 increase, or peripheralize.

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

COMMON ERRORS TO AVOID: Miscounting vertebral 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, and failing to maintain correct starting position.

Figure 11. *Contour of the Lumbar Curve -- Flexible Ruler -- Sustained Slouched Sitting*

Contour of the Lumbar Curve -- Flexible Ruler -- Sustained Slouched Sitting

PURPOSE: Measurement of the lumbar spine contour in the sagittal plane, using a flexible ruler, with the subject in a sustained slouched seated posture.

INSTRUMENTS REQUIRED: Stopwatch, flexible ruler, felt tip pen, and marking dots.

DEFINITION OF TERMS: Peripheralization.

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.

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

ORDER OF ASSESSMENTS: None.

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's thumbs are placed beneath the anatomic area where the posterior superior iliac spines (PSISs) are located. The thumbs then are slid upward (avoid excessive tissue roll) 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 finger of the examiner's hand puts pressure over the spinous process at that level (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. 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. 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 to the pencil mark. The degree angle of lumbar curve is calculated (pp 62-64). The degree angle is recorded on the Recording Form.

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 increase, or peripheralize.

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

COMMON ERRORS TO AVOID: 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, and failing to maintain correct starting position.

Starting position

Internal rotation

External rotation

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

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

PURPOSE: 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 position on the table.

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

ORDER OF ASSESSMENTS: Measure first the right leg and then the left leg.

PROCEDURE: The examiner instructs the subject to slide to the right 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 remains extended. The examiner positions the gravity 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 while the examiner stablizes the left side of the pelvis. The degrees (*to the nearest 5 degree interval*) are noted on the Recording Form. The right hip joint is returned to neutral and the zero point rechecked on the gravity goniometer. If the reading is not at zero, the test is repeated. Then external rotation is measured while the right pelvis is stabilized. The degrees (*to the nearest 5 degree interval*) are noted on the Recording Form, and the hip returned to neutral. If the goniometer reading is not at zero the test is repeated.

To measure the left 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 left knee to 90 degrees of flexion so that the sole of the left foot faces the ceiling. The right leg remains extended. The examiner aligns the gravity goniometer with the long axis of the tibia of the left leg and sets the zero point. First, the examiner measures and records internal rotation while the examiner stablizes the right side of the pelvis. The degrees (*to the nearest 5 degree interval*) are noted on the Recording Form. The left hip joint is returned to neutral, and the zero point rechecked on the gravity goniometer. If the reading is not at zero, the test is repeated. Then external rotation is measured while the left pelvis is stabilized. The degrees (*to the nearest 5 degree interval*) are noted on the Recording Form, and the zero point rechecked on the gravity goniometer. If the reading is not at zero, the test is repeated.

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 during internal rotation or on the ***same side*** during external rotation.

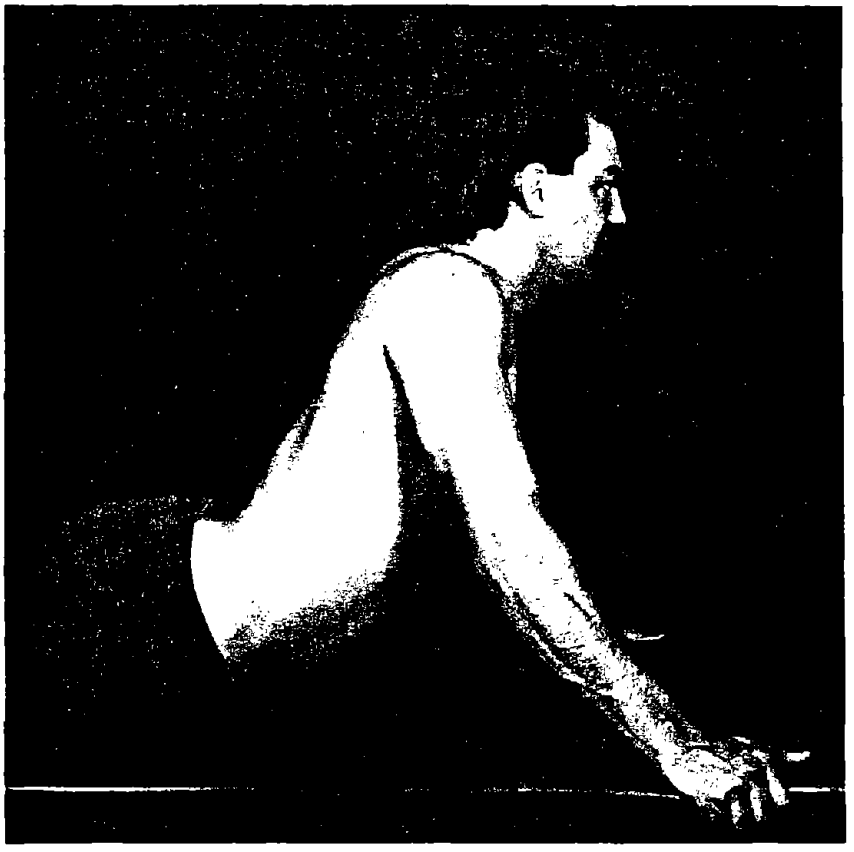


Figure 13. *Sustained Extension from Prone Position- Press-up Symptom Change*

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

PURPOSE: Assessment of the change in symptoms with sustained extension of the lumbar spine in the prone position.

INSTRUMENTS REQUIRED: Stopwatch.

DEFINITION OF TERMS: Peripheralization and parasthesia.

CONTRAINDICATION: Peripheralization of symptoms in the prone position.

STARTING POSITION OF SUBJECT: Assumes a comfortable prone position with the palmar surface of the hands grasping the edge of 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.

ORDER OF ASSESSMENTS: None.

PROCEDURE: Before the test, the subject is asked if there is any feeling of pain and/or parasthesia (i.e., *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 shoulders and trunk up while leaving the pelvis flat on the table. The subject is told to maintain this postion 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 position. The examiner asks if there has been any change in symptoms with returning movement or at the starting position. Record the following results on the Recording Form:

1. If there is no change in symptoms with the procedure or if the test is contraindicated, check the appropriate response in the Recording Form and proceed to the next test.

2. If the subject performs the test and reports changes in pain and/or parasthesia, complete Grid A and Grid B using the following instructions:

Grid A (Pain): Check the appropriate block for back, right leg, and left leg pain. Use symbols noted in the Key. If pain is felt at rest, for example; place an X in the appropriate box under the column "*Before Initiation.*" Use the "*Symptoms at Initiation*" column to record changes coincident with the start of the test. Use the "*Symptoms at Termination*" column to record changes present when the neutral position is resumed. Use the "*Time to Onset*" column 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 (Parasthesia): Use it identically to that of Grid A, except record paresthesia rather than pain.

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 failure.

INDICATIONS TO DISCONTINUE TEST: Symptoms increase, or peripheralize.

POSITION IN WHICH TO LEAVE SUBJECT: Move the subject to a supine position.

COMMON ERRORS TO AVOID: Failing to keep pelvis flat on the table.

Figure 14. *Passive Single Straight Leg Raising*

Passive Single Straight Leg Raising

PURPOSE: 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 position with hips and knees extended. The pelvis is in a neutral position with respect to anterior/posterior pelvic tilt.

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

ORDER OF ASSESSMENTS: If there is a symptomatic leg, the *asymptomatic* leg is tested first. If there is not a symptomatic leg, test right side first.

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 of the gravity goniometer.

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 grasp the gravity goniometer. The right hand is placed on the anterior surface of the thigh just above the knee to help keep the knee straight. The examiner slowly raises the leg from the table until the opposite thigh begins to move into flexion. The examiner reads the goniometer to the nearest 5 degree interval and records the angle on the Recording Form. The leg is lowered to the starting position. The examiner moves to the other side of the table; and the same procedure is repeated with the right hand under the ankle and the left hand placed above the knee.

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 failure.

INDICATIONS TO DISCONTINUE TEST: Failure on second attempt.

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

COMMON ERRORS TO AVOID: In the examined limb, the knee is not maintained in full extension, hip rotation is not controlled in a neutral position, and hip abduction and adduction are not controlled in a neutral position. If the contralateral extremity lifts off the table, then posterior pelvic tilt of the lumbar spine occurs.

Figure 15. *Passive Double Straight Leg Raising*

Passive Double Straight Leg Raising

PURPOSE: Assessment of passive double straight leg raising compared to passive single straight leg raising.

INSTRUMENTS REQUIRED: None.

DEFINITION OF TERMS: None.

CONTRAINDICATIONS: Subject cannot assume the starting position.

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

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

ORDER OF ASSESSMENTS: None.

PROCEDURE: If standing on the left side of the subject, the examiner places his or her left hand on the posterior aspect of the ankles, just proximal to the calcanei. The right hand crosses both lower thighs just proximal to the knees. The examiner slowly raises the legs from the table with the knees straight until the examiner encounters resistance. The examiner reads the goniometer to the nearest 5 degree interval and records the angle on the Recording Form. The legs then are lowered. The examiner grades the response as compared to the most limited side in the Passsive Straight Leg Raise (*PSLR*) test:

1. Less than *PSLR* .
2. Equal to *PSLR*.
3. Greater than *PSLR*.

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 failure.

INDICATIONS TO DISCONTINUE TEST: Failure on second attempt.

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

COMMON ERRORS TO AVOID: In the examined limbs, the knees are not maintained in full extension.

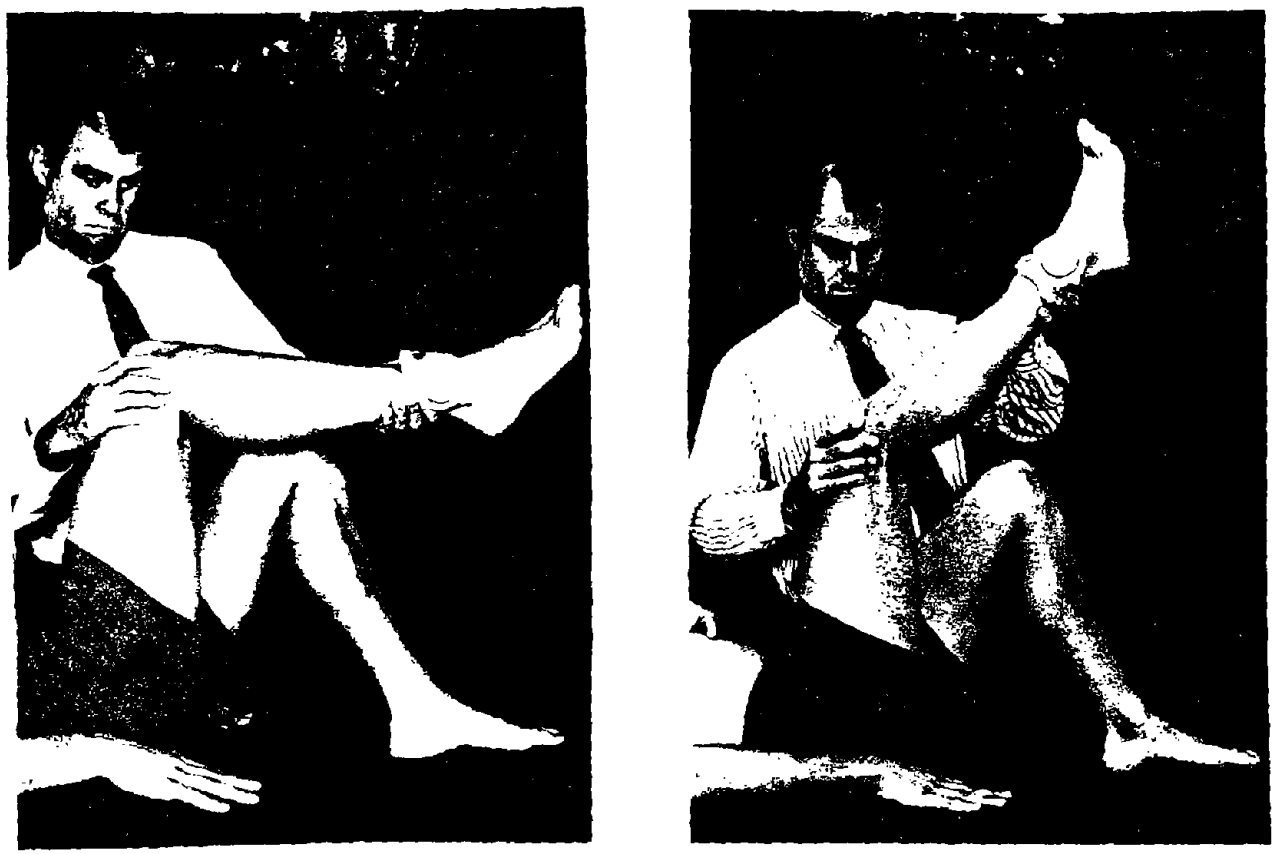


Figure 16. *Hamstring Length and Associated Lumbar Flexibility*

Hamstring Length and Associated Lumbar Flexibility

PURPOSE: Measurement of the relative lengths of the right and the left hamstring muscles and associated lumbar flexibility by the use of a gravity goniometer.

INSTRUMENTS REQUIRED: Gravity goniometer.

DEFINITION OF TERMS: Peripheralization.

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

STARTING POSITION OF SUBJECT: Assumes a relaxed supine position with the right lower limb being measured in hip and knee flexion.

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

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

PROCEDURE: Before testing, the examiner assesses the passive ROM of the hip and knee joints bilaterally. The left leg (*non-measured*) is placed in a position of hip and knee flexion with the foot flat on the table, and the heel in line with the mid patella region of the extended right leg. The examiner positions the gravity goniometer so that it aligns with the long axis of the right fibula and sets the zero point of the gravity goni-ometer. 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 right lower leg. The examiner extends the right knee until resistance is felt. The degrees of flexion (*to the nearest 5 degree interval*) are noted on the gravity goniometer. The knee 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.

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 failure.

INDICATIONS TO DISCONTINUE TEST: Failure on second attempt.

POSITION IN WHICH TO LEAVE SUBJECT: In a supine 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 hamstring tension.

Figure 17. *Hip Flexor Muscle Group Strength*

Hip Flexor Muscle Group Strength

PURPOSE: Comparison of the isometric strength of the right and left hip flexor muscle groups.

INSTRUMENTS REQUIRED: None.

DEFINITION OF TERMS: Peripheralization.

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

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

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

PROCEDURE: The right hip flexor group strength is assessed first. The examiner places the right hip in 90 degrees flexion, neutral, between internal and external rotation, and 90 degrees knee flexion. While stabilizing the left knee as noted in the starting position, the examiner applies resistance distally to the anterior surface of the thigh. The muscle strength is assessed. The right hip and knee are returned to the starting position, the examiner moves to the left side of the subject, and repeats the test on the left leg. A comparison of the isometric strength of the right and left hip flexor muscle groups is recorded on the Recording Form. The subject is allowed to resume a relaxed supine 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, record N/A on the Recording Form, and explain the reason for failure.

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 position.

COMMON ERRORS TO AVOID: Internal or external hip rotation during the resistive component of the examination.

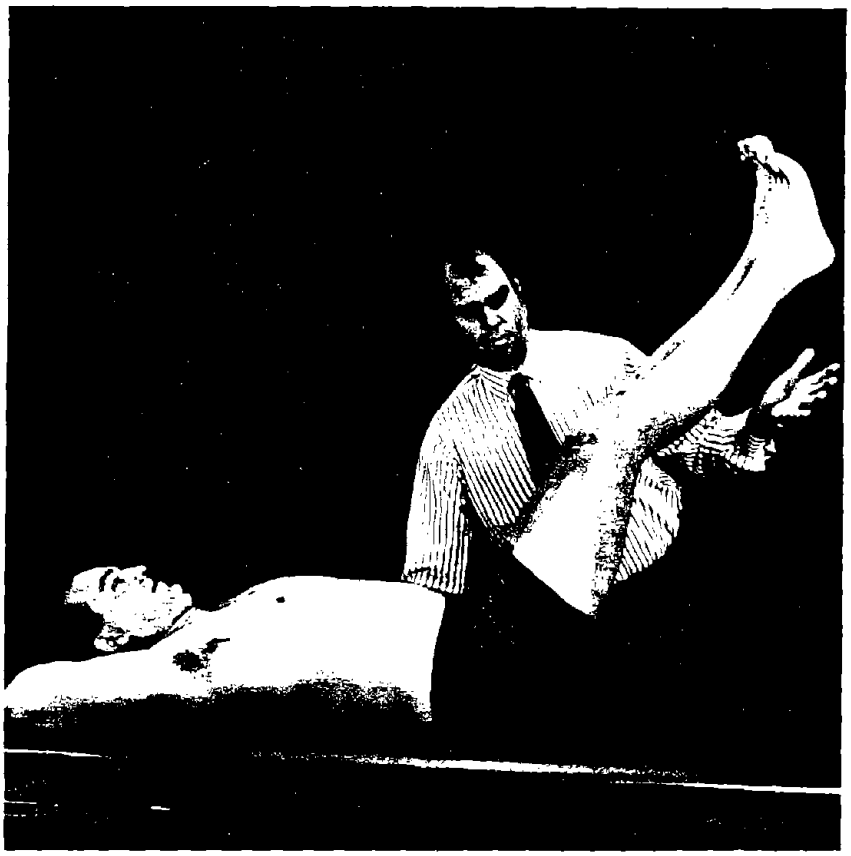


Figure 18. Lower Abdominal Muscle Strength

Lower Abdominal Muscle Strength

PURPOSE: 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. Peripheralization.

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 and knees are placed in flexion, with the soles of the feet resting on the table.

STARTING POSITION OF EXAMINER: At the side of the examining table.

ORDER OF ASSESSMENTS: None.

PROCEDURE: The examiner places one hand underneath the low back of the subject, with the finger tips against the region of L2 to L5, and the dorsum of the hand against the table surface. While keeping the lower back flat against the examiner's palpating fingers, and the hips in flexion, the examiner instructs the subject to extend the knees (one at a time) to a starting position of 70 to 90 degrees of hip flexion. Through the subject's voluntary contraction of the abdominal muscles to hold the low back flat, and through the action of hip flexors and knee extensors, the extended legs are slowly lowered. The examiner ascertains whether the low back remains flat against the table by the examiner's fingers. Two practice tests are performed as the subject is instructed to keep his back flat against the examiner's fingers while the examiner assists by giving some support during the leg lowering. On the third trial, the subject lowers the legs without assistance from the examiner but the examiner keeps one hand below the legs of the subject and the other hand ascertains that the low back remains flat against the examiner's fingers. The degree of hip flexion when the back lifts off the examiner's fingers (i.e., the pelvis begins to anteriorly tilt) is estimated and recorded using the graphic on the Recording Form.

Less than 60 percent: Check here if the lumbar spine lifts off the examiner's fingers when the angle of hip flexion is between 90° and 60°.

Greater than 60 percent: If the lumbar spine remains flat against the examiner's fingers after 60 degrees of hip flexion.

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 failure.

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: In a supine position.

COMMON ERRORS TO AVOID: Examiner does *not* accurately indicate when the pelvis begins to anteriorly tilt. Subject does not understand what is required by the test.

Figure 19. *Gluteus Maximus Length and Associated Lumbar Flexibility*

Gluteus Maximus Length and Associated Lumbar Flexibility

PURPOSE: Assessment of the length of the gluteus maximus muscle, and associated lumbar flexibility.

INSTRUMENTS REQUIRED: None.

DEFINITION OF TERMS: Peripheralization.

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 right side of the examining table.

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

PROCEDURE: With the subject's left leg in extension, the examiner places the right leg in flexion at the knee and at the hip. The examiner's left hand is positioned palm up with the fingers curled, so that the patient's right ischial tuberosity is resting on the dorsal surface of the curled fingers. The examiner gently pushes the subject's right leg toward the chest with the right hand. When the ischial tuberosity lifts off the examiner's hand, the examiner estimates the degree of hip flexion. The left leg must remain in extension. The leg then is lowered, the examiner moves to the other side of the table, and the procedure is repeated on the left leg. The estimated visual angle of hip flexion is recorded on the Recording Form.

Normal: Hip flexion greater than 120° is attained before the ischial tuberosity lifts off the palpating fingers.

Moderate Limitation: Hip Flexion between 100°- 120° is attained before the ischial tuberosity lifts off the palpating fingers.

Marked Limitation: Hip flexion less than 100° is attained before the ischial tuberosity lifts off the palpating fingers.

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 failure.

INDICATIONS TO DISCONTINUE TEST: Failure on second attempt.

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

COMMON ERRORS TO AVOID: Movement of the non-measured leg into hip flexion.

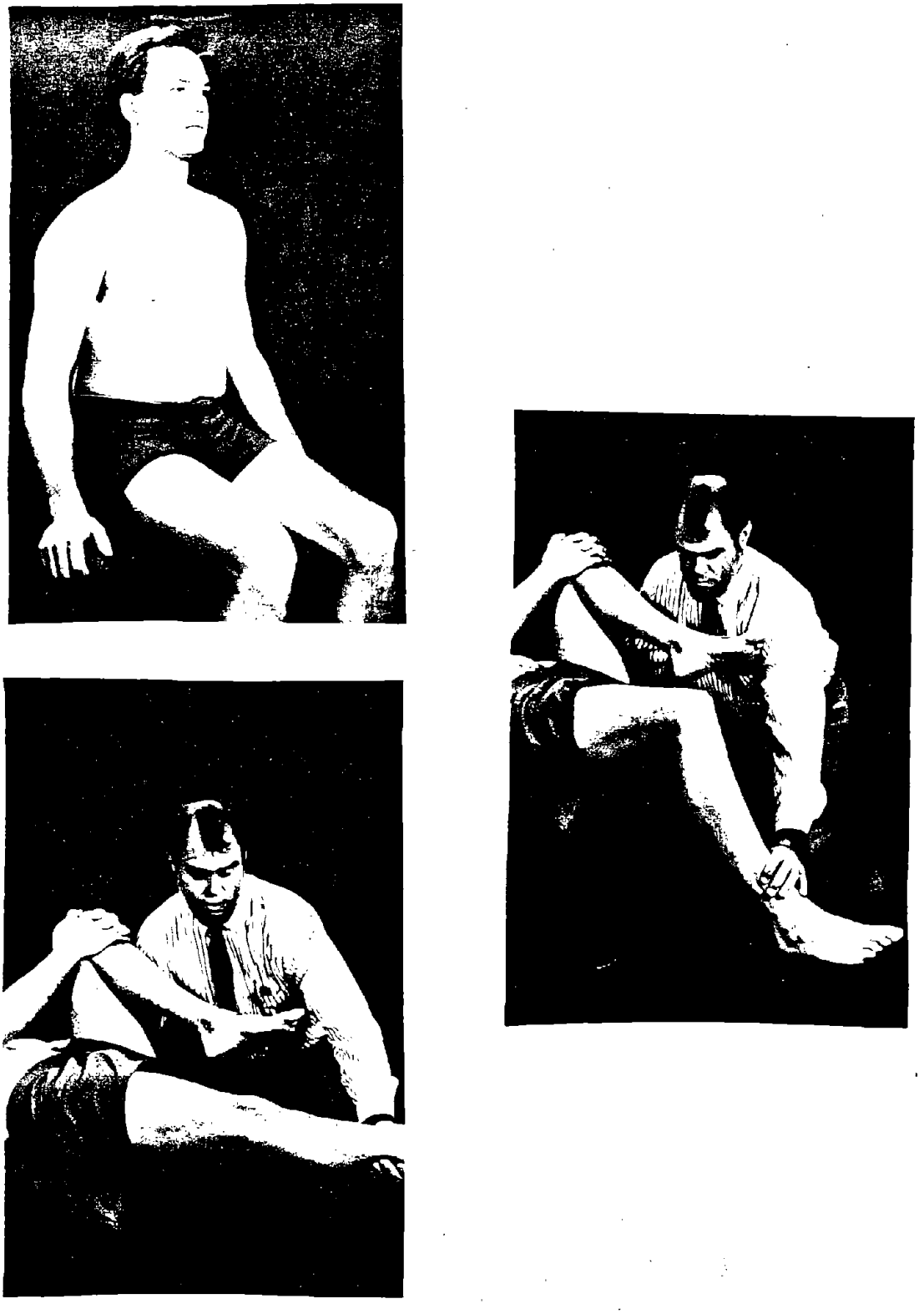


Figure 20. Hip Flexor Length

Hip Flexor Length

PURPOSE: Assessment of the length of the hip flexor musculature (iliopsoas, rectus femoris, and tensor fascia latae). The test is performed passively and involves determining whether the tightness is caused by one, or by a combination of two or more, hip flexor muscles.

INSTRUMENTS REQUIRED: None.

DEFINITION OF TERMS: Peripheralization.

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, one-half of the thigh is off the edge of the table.

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

ORDER OF ASSESSMENTS: First the right side and then the left. Testing order is one joint hip flexor, two joint hip flexor, and tensor fascia latae.

PROCEDURE: As the subject is assisted in assuming a supine position both knees are brought toward the chest. The examiner places one hand underneath the low back of the subject, with the fingertips against the region of L2 to L5, and the dorsum of the hand against the table surface. The examiner instructs the subject to hold the left knee toward the chest in order to keep the low back flat against the examiner's fingers.

Hip flexor length: The examiner then lowers the right leg, the hip neutral between internal and external rotation, and knee extended. The lower back remains flat. The estimated degree of hip flexion is noted on the Recording Form.

Two joint hip flexor length: If the hip joint can be fully extended when the knee is extended, there is normal length in the one-joint hip flexor. While the hip is in the extension posture, the knee is flexed passively to approximately 90 degrees. The lower back remains flat against the table. The change in the degree of hip flexion is noted on the Recording Form.

Tensor Fasciae Latae: (*Not depicted in photographs*) The examiner moves the right leg back to full hip flexion. The lower back remains flat. The right leg is lowered by the subject. The examiner observes the abduction or internal rotation of the right hip or external rotation of the tibia as the right leg lowers into extension. The observation is then recorded on the Recording Form.

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 left side of the table and repeats the procedure with the left leg.

TIMING: None.

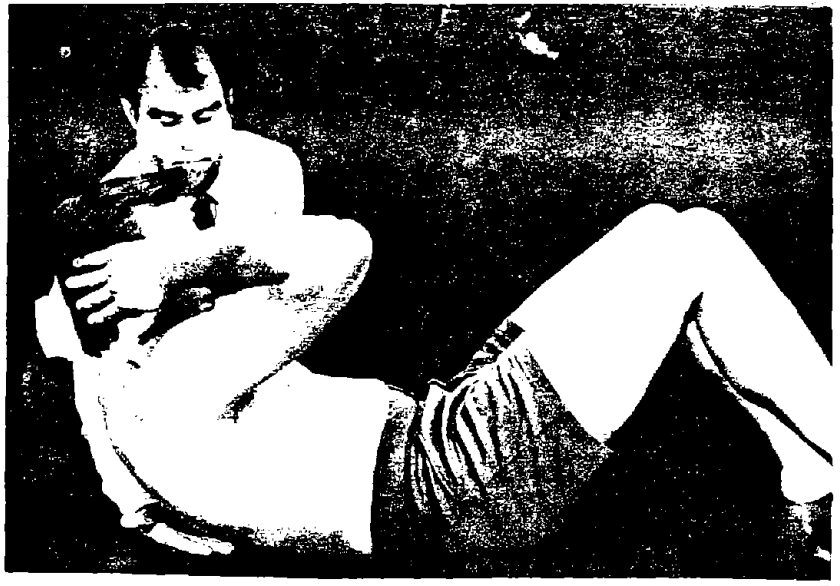
REST PERIODS: None.

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, record N/A on the Recording Form, and explain the reason for failure.

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: In a supine position.

COMMON ERRORS TO AVOID: Subject does not maintain the lumbar spine flat against the table. Patient is not positioned far enough over the end of the table to permit full knee flexion during testing.



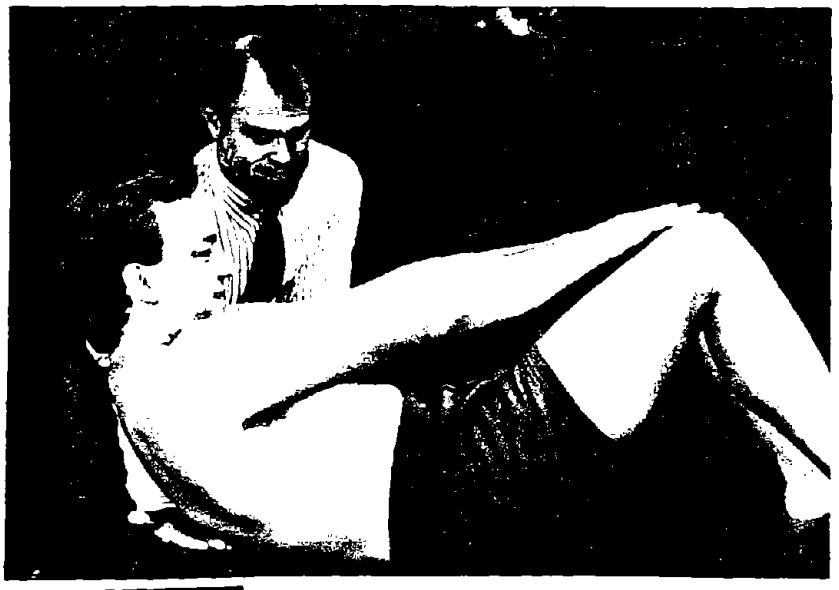


Figure 21. Upper Abdominal Muscle Strength

Upper Abdominal Muscle Strength

PURPOSE: 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. Peripheralization.

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

STARTING POSITION OF SUBJECT: Assumes a supine position, with the hips and knees positioned in slight flexion and the hands locked behind the head.

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

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

PROCEDURE: The examiner asks the subject to raise the head and shoulders "curling" the trunk. This motion should be accomplished without using any initial velocity; the subject must lift the head and upper thoracic region from a dead start. If the subject cannot complete the movement, ask the subject to fold the arms across the chest and try again. If the subject cannot complete the movement, ask the subject to move the arms to the side of the body, and try the procedure again. After the procedure(s), allow the subject to resume a comfortable supine position.

The ability to perform the test is recorded on the Recording Form. The following grading system is used:

A: Subject performs the procedure to a point at which the scapulae are off the table with hands locked behind the head.

B: Subject completes the procedure to a point at which the scapulae are off the table with arms folded across the chest.

C: Subject completes the procedure to a point at which the scapulae are off the table with arms extended at the sides.

D: Subject cannot complete the procedure.

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 failure.

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: In a supine position.

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

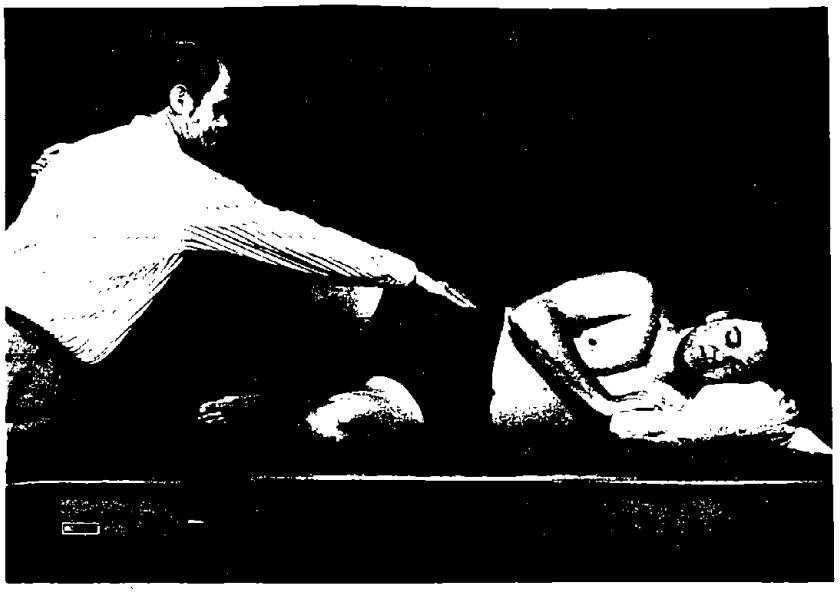


Figure 22. Dynamic Hip Abduction

Dynamic Hip Abduction

PURPOSE: A comparison of the dynamic strength of the right and left muscles of hip abduction.

INSTRUMENTS REQUIRED: Wall marker.

DEFINITION OF TERMS: Peripheralization.

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

STARTING POSITION OF SUBJECT: With the examining table positioned against the wall, the subject is asked to lie on the left side with the back against the wall.

STARTING POSITION OF EXAMINER: Standing and facing the subject.

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

PROCEDURE: The subject is instructed to flex the left 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 right leg upward (abduction) while palpating the iliac crest. When the pelvis starts to tilt upward, 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 abduct the right leg, keeping the knee straight and the heel in contact with the wall. The subject is asked to practice the test movement two or three times, and then try to raise the leg to the established passive end point ten times. After this ten (or as many, up to ten, as the subject can perform), the subject is told to lie on the right side so 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 try to lift the leg ten times. The subject then is allowed to resume a supine position. The subject is asked of right or left degree of difficulty for completion of this test.

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.

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 failure.

INDICATIONS TO DISCONTINUE TEST: Failure on second attempt.

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

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

The Instruments

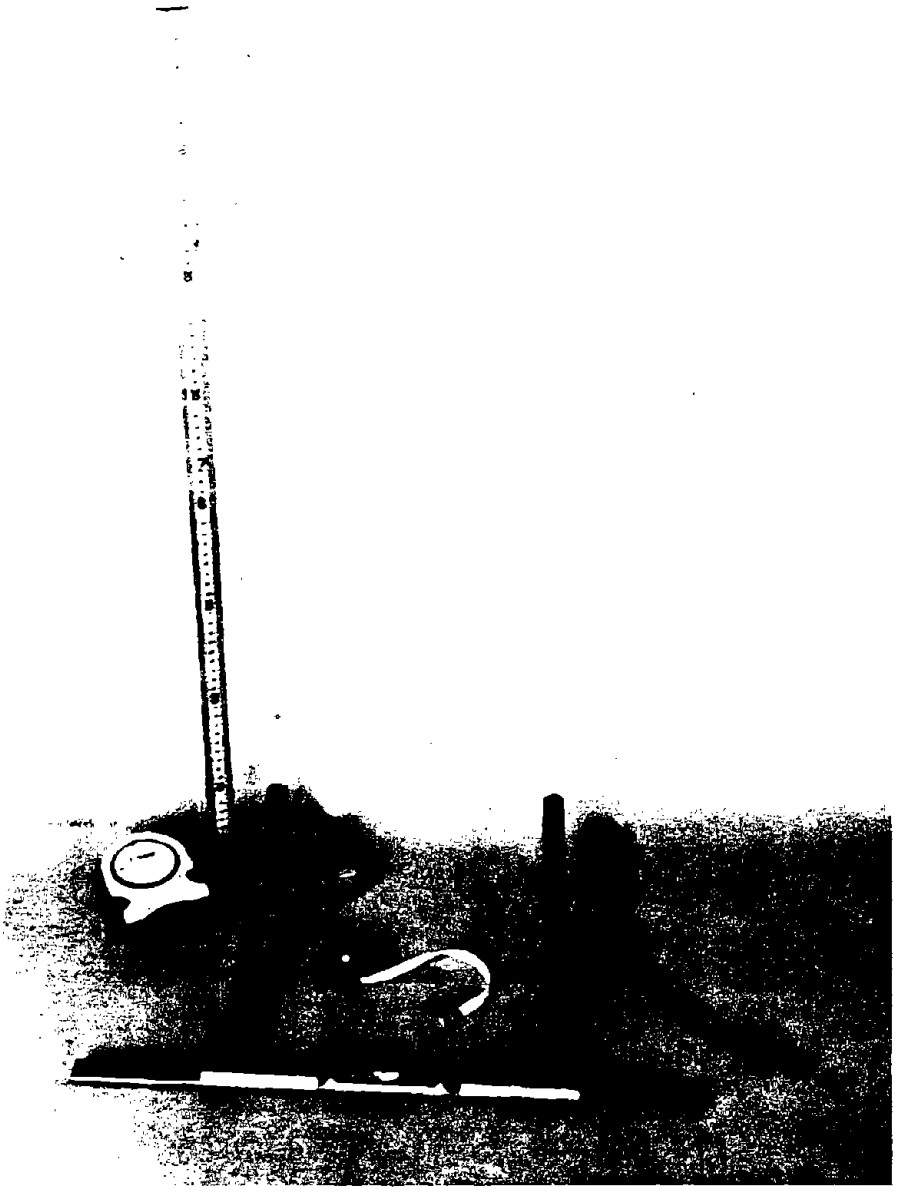


Figure 23. The instruments.

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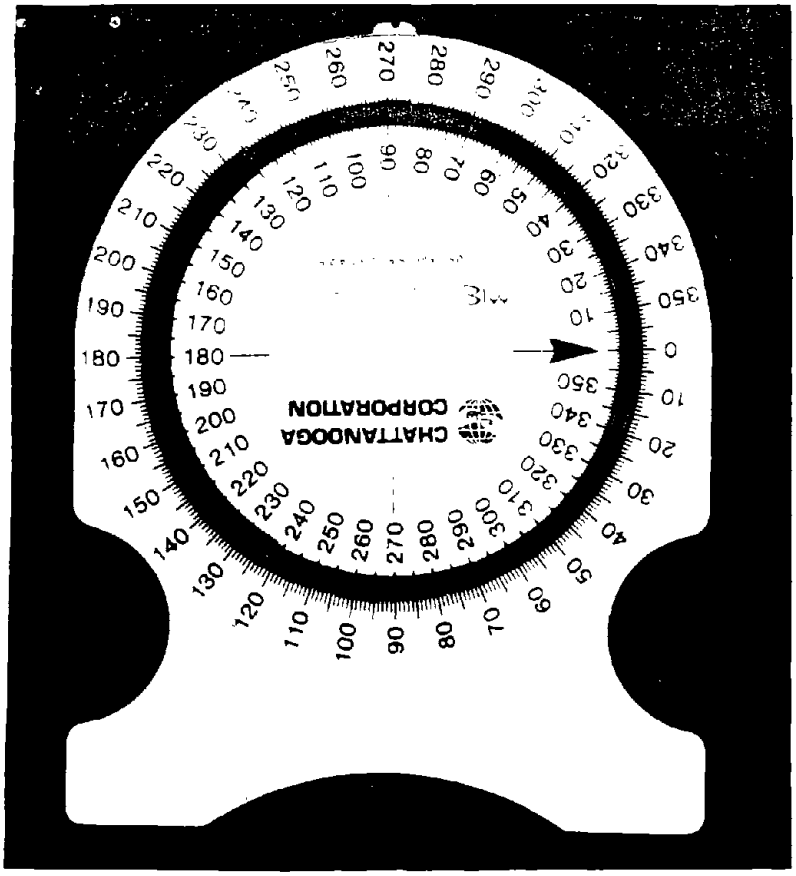

Figure 24. Bubble goniometer.

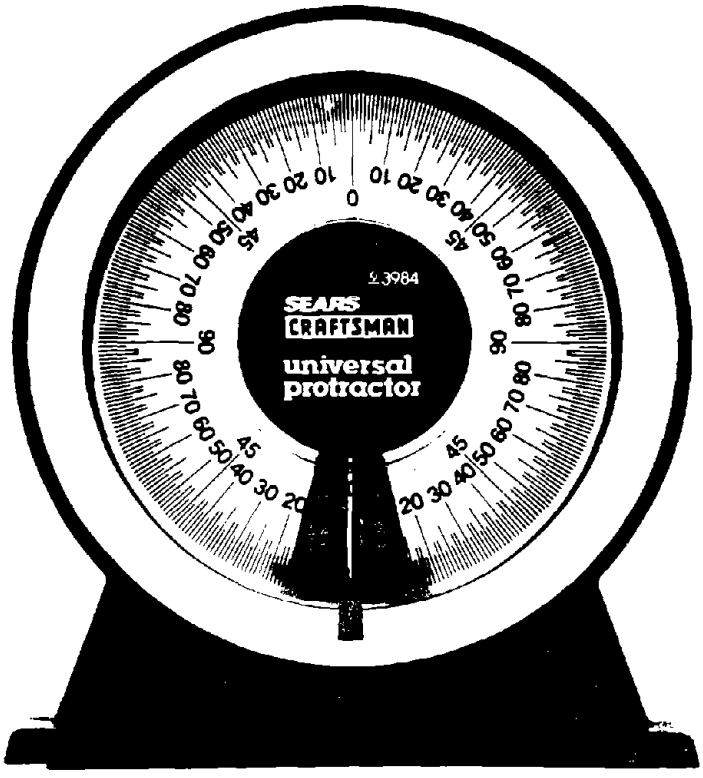

Figure 25. Gravity goniometer.

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

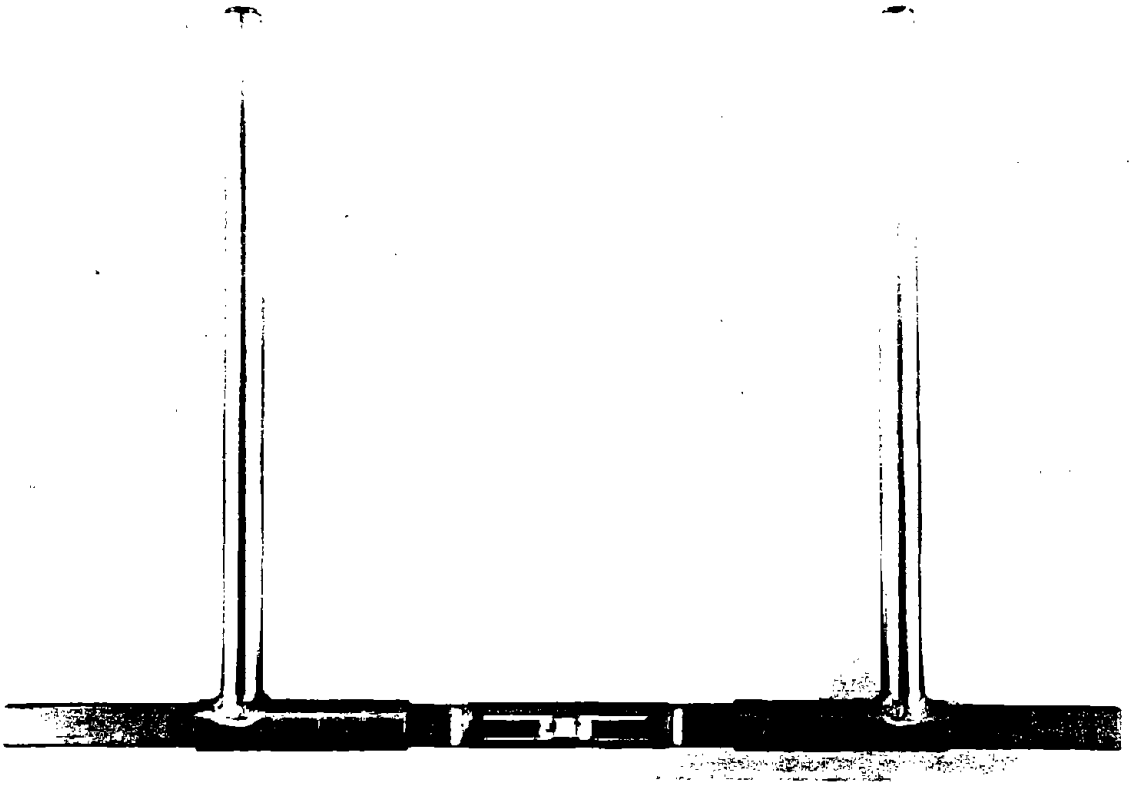

Figure 27. A "crest tester."

Two Sources:

Pelvic Level	Med-Level
Model PC 5029A	Model 2000
J.A. Preston Corp.	Ballert International, Inc.
60 Page Road	3677 Woodhead Drive
Clifton, New Jersey	Northbrook, Illinois
07012	60062-2450
1-800-631-7277	1-800-345-3456

NOTE: MENTION OF PRODUCT OR SOURCE DOES NOT CONSTITUTE ENDORSEMENT BY THE U.S. GOVERNMENT AND NIOSH.

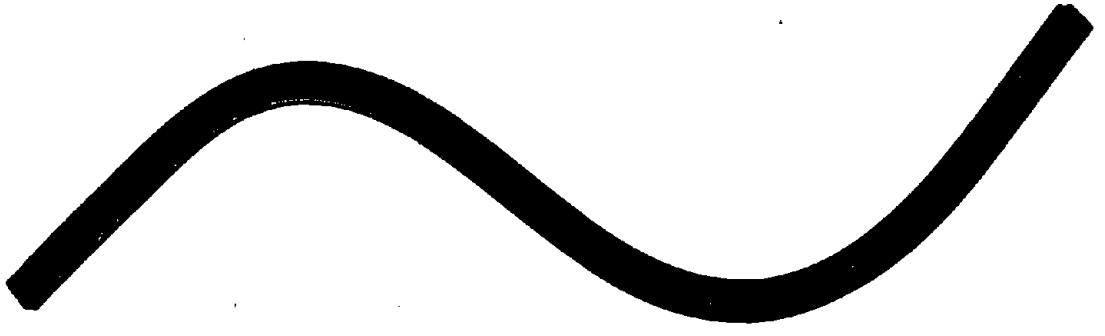

Figure 28. *Flexible (Architect's) ruler. In this figure it is shaped as a sine wave.*

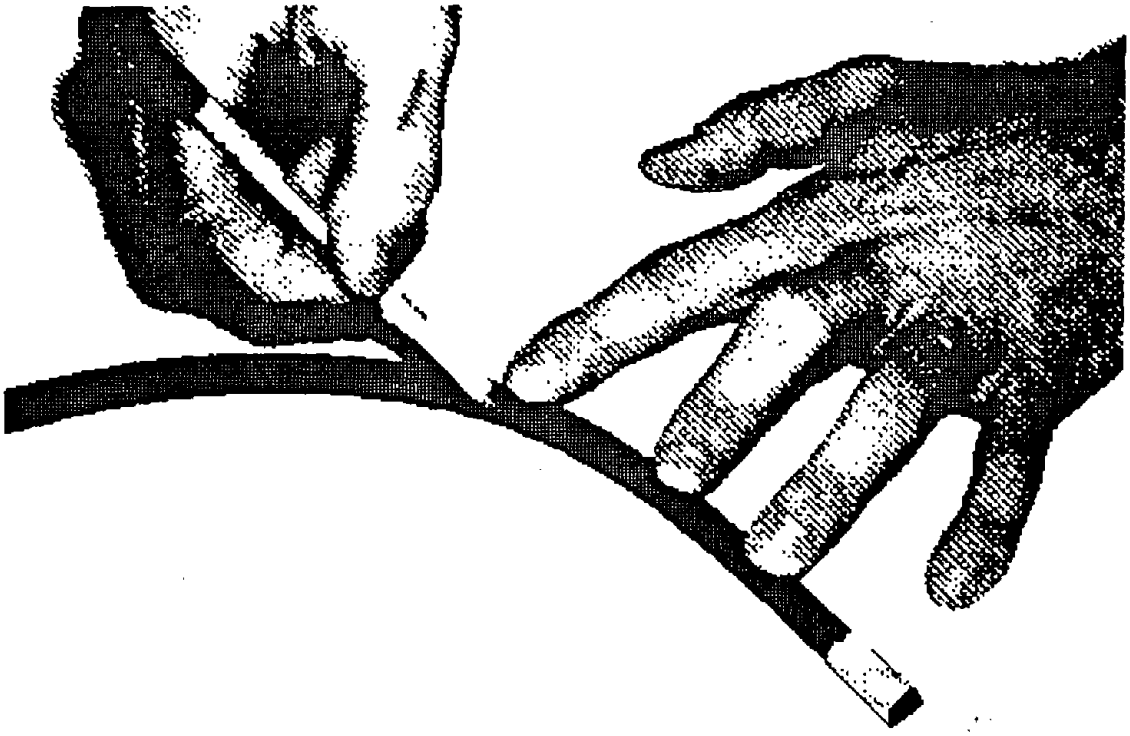

Figure 29. *Transferring the shape of the lumbar spine to the poster board.*

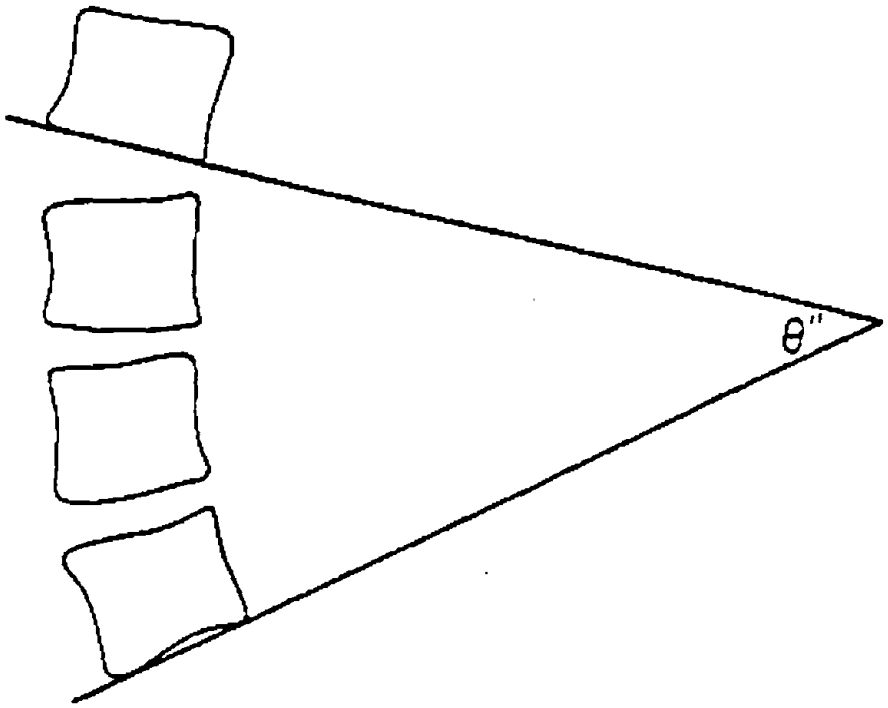

Figure 30. *Derivation of the Vertebral Angle θ*

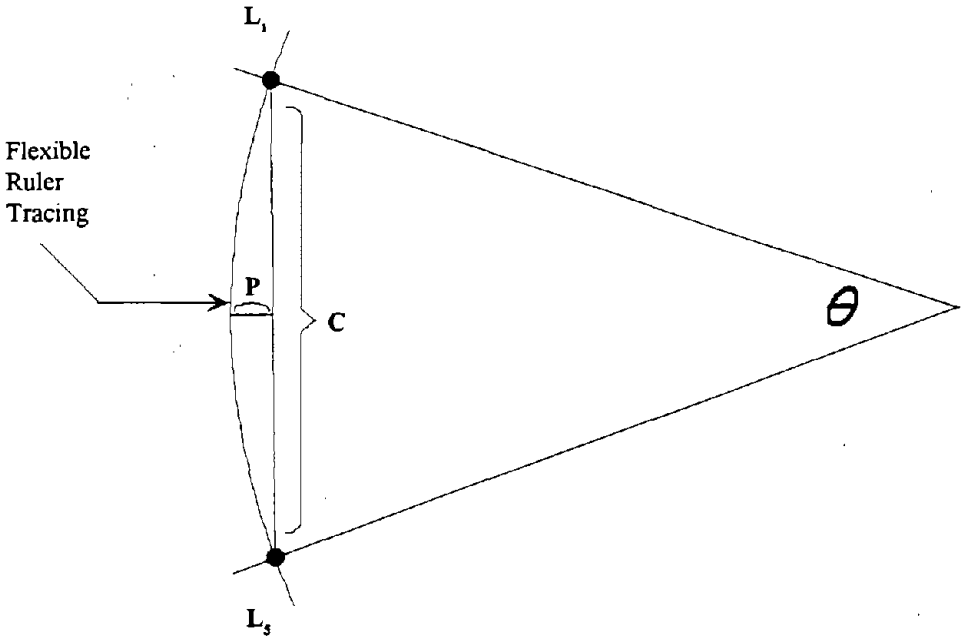

Figure 31. Trigonometric derivation of the angle representing the shape of the lumbar spine.

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

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Standing

Contour of the Lumbar Spine - 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.

Anterior Superior Iliac Spines - 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 excursion 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.

Posterior Superior Iliac Spines - 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.

Contourof the Lumbar Spine-flexible ruler-
relaxed sitting degrees _____ degrees

Contourof the Lumbar Spine-flexible ruler
sustained erect sitting _____ degrees

Contourof the Lumbar Spine-flexible ruler
sustained slouched sitting _____ degrees

TEST: Contourof the Lumbar Spine - 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 - (in relaxed sitting posture)

TEST: Contour of the Lumbar Spine-flexible ruler - sustained erect sitting.

CONTRAINDICATION: Peripheralization of symptoms with brief sitting

top

anterior posterior

bottom

Sustained erect sitting

Flexible ruler

TEST: Contourof the Lumbar Spine - flexible ruler - sustained slouched sitting.

CONTRAINDICATION: Peripheralization of symptoms with brief sitting.

top

anterior posterior

bottom

Sustained slouched sitting

Flexible ruler

Prone Position

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	Symptoms 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	Symptoms 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 position.

<u>Supine lying</u>

Passive Single Straight Leg Raising

degrees right _____
degrees left _____

CONTRAINDICATION: Patient cannot assume the starting position.

Passive Double Straight Leg Raising

1. Less than PSLR _____
2. Equal to PSLR _____
3. Greater than PSLR _____

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

Hamstring Length and Associated Lumbar Flexibility

degrees right _____
degrees left _____

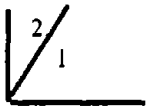
CONTRAINDICATION: Peripheralization of pain with assumption of the starting position.

Hip Flexor Muscle Group Strength

Right stronger _____
Left stronger _____
Symmetrical _____

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

Lower Abdominal Muscle Strength



1. Less than 60 percent _____
2. Greater than 60 percent _____

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

Gleuteus Maximus Length and Associated Lumbar Flexibility

	Right	Left
Normal (greater than 120°)	___	___
Moderate (100 to 119°)	___	___
Marked (99° or less)	___	___

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

Hip Flexor Length

One Joint Test

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

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

Two Joint Test

	Right		Left
hip flexion angle (to the nearest 5 degree interval)	____	degrees	____

Tensor Fascia Latae

hip abductionand external rotation of tibia: (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
Complete with arms behind head	A	[ ]
Complete with arms across chest	B	[ ]
Complete with arms extended	C	[ ]
Cannot complete	D	[ ]

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

<u>Side Lying</u>

Dynamic Hip Abduction

Right stronger [ ]
Left stronger [ ]
Symmetrical [ ]

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

Glossary

GLOSSARY

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

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 signs 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.

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 center.

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 drawn toward each other. A movement which 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 desirable 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 or 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 concavity (hollow) in the curvature of the lumbar spine as viewed from the side.

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 (90^0) 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.

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 existence 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 or endurance; power to resist force.

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

Subjective - Pertaining to or perceived only by the affected 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 patient's condition. Such evidence as perceived by the patient as a change in 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.