PROPRIOCEPTION

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1. Background and rationale

The electrogoniometer is a device that can measure the angle at which the knee is bent. It will be used to test ***proprioception*** at the knee of study participants. Proprioception is position sense (the term we will use in this manual), the body's ability to know where our limbs are in space.

Impaired or altered position sense may play a role in the development and progression of knee arthritis by causing abnormal stresses on the joint during weight-bearing activities.

To measure position sense, the electrogoniometer will be used to test a participant's ability to accurately reproduce an angle at which their knee is bent: The electrogoniometer is attached to the lateral (outer) aspect of the participant's leg, across the knee joint. The participant is seated with their legs bent at the knees and freely dangling. With the participant's eyes closed, and a tray to block the view of their leg, their leg is extended at the knee to a given angle, and they will be asked to hold that position for 5 seconds before relaxing their leg to the freely dangling position. With their eyes still closed, the participant will then be asked to reproduce that angle. The difference between the test angle and the reproduced angle will give us an indication of a participant's position sense.

The examination will consist of two practice trials and 10 measurement trials.

The examination will be performed on the knee of the participant's dominant leg.

2. Equipment and supplies

- Model SG150 twin axis goniometer, ADU301 display unit, 2 x C1000 interconnect leads, extra battery
- examination table (or high chair) where the participant can sit on the edge with their legs dangling freely
- wedge to place under participant's thigh
- tray to block the participant's view of their legs
- extra shorts (if participant forgets to bring their own shorts)
- hand-held goniometer (for calibration)
- ruler and pen (washable ink)
- double-sided tape
- surgical tape
- alcohol swabs and damp cloth to clean endblocks before placing on each participant
- pen and data entry forms to record results

2.1 Use and care of the electrogoniometer

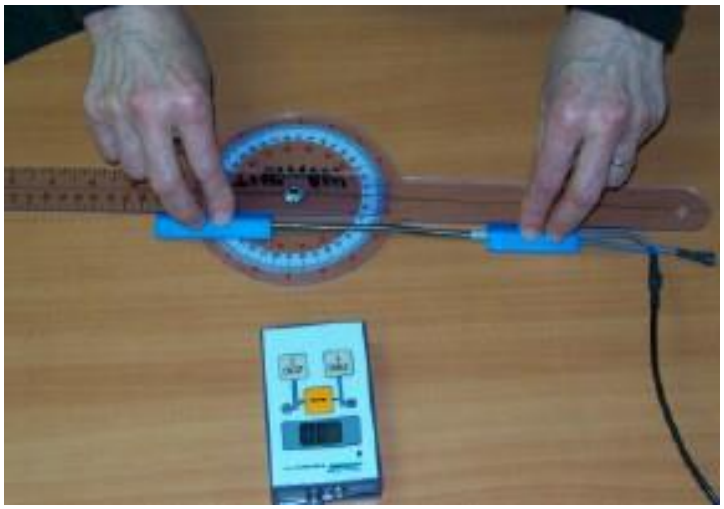
See the goniometer owner's manual for directions on use and care.

Electrogoniometers are fairly sturdy, but will break if abused, so they must still be handled with care. In order to avoid twisting the goniometer (which can damage it), it should be carried either in two hands or with one endblock resting on the forearm. Allowing the endblocks of the goniometer to swing freely (e.g., when attaching to the participant) should be avoided.

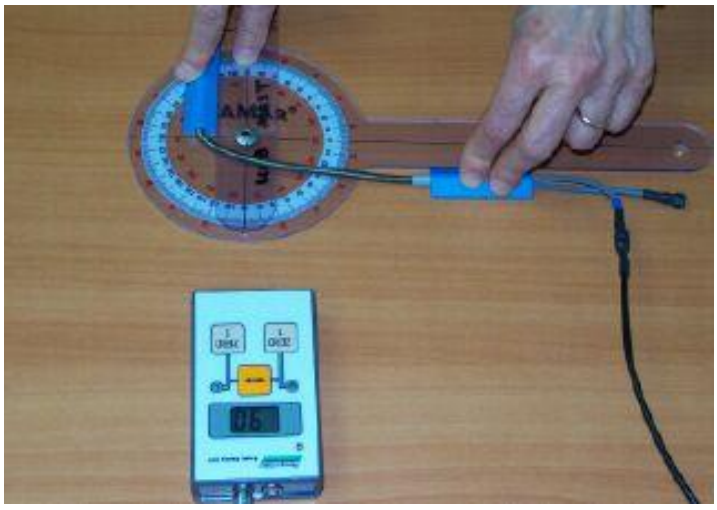
2.2 Calibration of the electrogoniometer

The electrogoniometer accuracy should be checked against a hand-held goniometer every day.

- Place the fixed (upper) endblock of the electrogoniometer (where the output leads attach) on the edge of the fixed arm of the hand-held goniometer.
- Place the telescopic (lower) endblock at 180 degrees, straight out from the fixed arm of the hand-held goniometer.



- Set electrogoniometer to "0."
- Lower the bottom endblock along with the moveable arm of the hand-held goniometer so that both the endblock and the moveable arm are at 90 degrees from the fixed arm of the hand-held goniometer.



- The reading should be between 88 and 92 degrees. If not, try calibration procedure again and if the reading still is not between 88 and 92 degrees, see QC officer.

3. Safety issues and exclusions

This exam is safe for all participants.

Several factors will make it difficult to collect valid data, and limbs with these characteristics should not be tested. These include:

- Knees that do not have at least 50° of movement between 90° and 180° should not be tested. It is unlikely that anyone enrolled in MOST will have this degree of limitation.
- A leg that has a cast, brace, or open wounds cannot be tested.
- In the rare instance that a participant cannot understand and/or follow the instructions, do not test the participant.

4. Examination procedures

4.1 Preparation

Room. Conduct the test in an environment that is warm and, most importantly, it needs to be quiet and away from external noises and distractions so that the participant can concentrate. It is imperative that this test not be rushed.

Dress. The electrogoniometer needs to be positioned and placed on the participant's bare thigh and calf. Unencumbered access to the thigh and calf will be necessary, and garments should not interfere with the wires of the electrogoniometer.
Acceptable attire during testing includes:

- Loose shorts (participants should be encouraged to bring street shorts)
- Socks (to keep feet warm)

The following should not be worn during testing:

- pants or sweat pants
- stockings or pantyhose
- long-underwear
- shoes
- knee brace
- bandage or cast on leg

Description of test

Explain the purpose of the test. With the participant sitting on the examination table and their legs dangling, sit facing them with the equipment near to hand.

Script: "Now I am going to test your proprioception, or position sense. That's what we call our ability to know where our limbs are in space. Let me explain this, what we're going to do and why.

"Information coming from our legs is very important for letting us know exactly where our legs are and how we are moving. If I close my eyes *(examiner closes their eyes)* and bend my knee *(examiner bends knee to about 30°)*, I can remember where my leg was and bring it to the same position later *(keeping eyes closed examiner bends same knee again to 30°)*."

4.2 Placement of the electrogoniometer

- First determine which leg to test. Ask the participant:
  Script: "Which foot do you or did you use to kick a ball?" If the answer is "right foot" examine the right leg. If the answer is "left foot" examine the left leg.

- The endblocks of the goniometer are to be placed on the outer aspect of the leg. The upper endblock (which has the output leads attached to it) is placed above the knee and the lower endblock is placed below the knee (see Figures 1 and 3).

- The participant should be seated on the edge of the examination table with their lower leg dangling over the edge of the table. The angle of knee flexion will probably be about 60 to 70 degrees. Place a wedge under the thigh to help bring up the thigh to approximately 90 degrees (i.e., parallel to the table).

Figure 1. Electrogoniometer schematic

A. Flexible spring wire connecting endblocks

B. Lower endblock (telescopic)

C. Upper endblock with output leads

D. Dual output leads

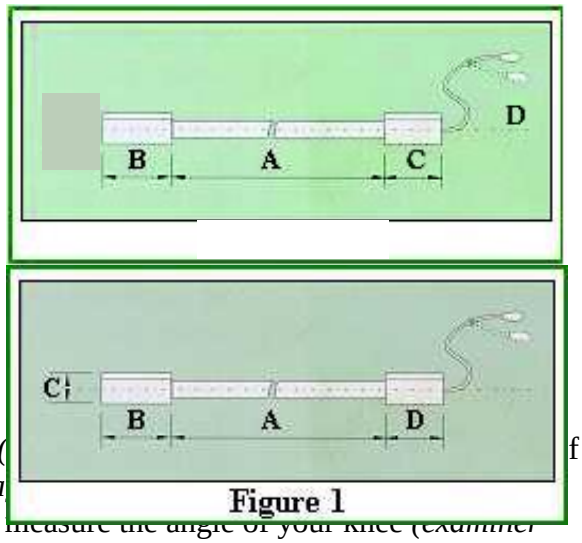


Figure 1

Show goniometer

Script: "Now I'm going to attach this device (f your leg using sticky tape *(examiner holds it a position)*. When the device is in place, it will measure the angle of your knee *(examiner slowly straightens their own knee)*. I need to make some marks on your leg with a washable pen to show me where to place the instrument that will measure your position sense."

4.2.1 Identification of landmarks

- Legs should be freely dangling and knees bent so that you can feel the joint line at the knee. The foam wedge should be placed under the thigh so that it is approximately parallel with the table top.

- Identify the lateral femoral epicondyle (Figure 2): Find the junction of the patellar tendon and inferior pole of patella. If your fingers move to the outside of it, you feel the "notch" opening that is the front of the lateral joint line. Follow that out laterally. The femoral epicondyle is the bony protuberance about 3/4 of an inch above (proximal) the joint line.

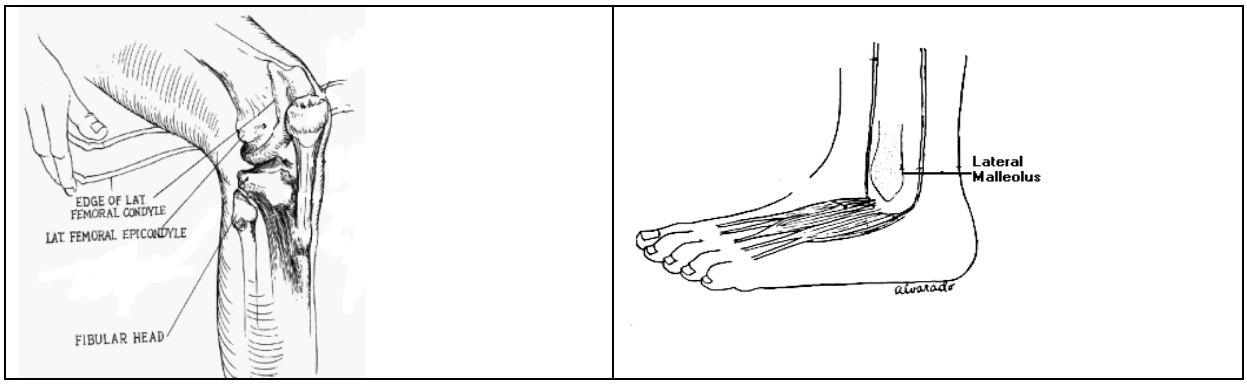


Figure 2

- The upper endblock (where the output leads attach) will be placed just above the lateral epicondyle of the femur *approximately aligned visually* with the greater trochanter. Draw a line about 4 inches long from just above the lateral femoral epicondyle pointing towards the greater trochanter (the bony prominence of the hip on the lateral upper thigh). This line will be approximately parallel with the table top.

- The lower endblock (B in Figure 1) will be placed just below the head of the fibula *approximately aligned visually* with the lateral malleolus (Figure 2). Draw a line about 4 inches long from just below the head of the fibula downward toward the lateral malleolus.

4.2.2 Attachment of endblocks to leg

After identifying landmarks on leg, attach the endblocks to the dominant leg.

- Ask the participant to extend their leg until the knee is as straight as possible. The participant can rest their leg on the tray table.

- Clean endblock with clean wet cloth in front of the participant. First position the lower endblock, holding it in place with your hand, then gently stretch the upper endblock to the thigh position (the wire between the two endblocks should be fully stretched).

- Holding the endblocks in place with your hands, have the participant slowly bend and then extend the leg at the knee several times. Watch the spring wire between the endblocks: It

should not kink during the movement of the leg. If it does, the endblocks need to be adjusted. Move the endblocks either a) forward or backward, or b) up or down, until the wire does not kink during flexion and extension at the knee. Use the lines that you've drawn for proper alignment. Trace along corners where endblock will be placed.

- Place the double-sided tape lengthwise on the flat, gray surface of the electrogoniometer's endblocks. The entire surface does not have to be covered with tape. Two pieces of double-sided tape, one at each end, should be sufficient for most participants. Time will be saved if you cut the tape in advance.

- Ask the participant to straighten their knee again. Use the lines on the skin to correctly position the endblocks. Place the lower endblock first, then stretch the upper endblock to the correct position.

- It's important that the sensor wires are stable. You can use clear surgical tape to tape these wires to the participant's thigh.

  Note: Surgical (one-sided) tape can be placed across the endblocks (perpendicular to the endblocks) and taped securely to the skin, in the rare instance that the endblocks will not stay in place without it. Record on data collection form if you use additional tape.

- Ask the participant to slowly bend and straighten the knee again to ensure that the spring wire between the endblocks does not kink. The spring wire must also not be touching the examination table or the wedge. Otherwise it will interfere with the recording of the angles. If it does either, reposition the blocks by repeating the above steps. See Figure 3 for illustration of correct placement of endblocks.

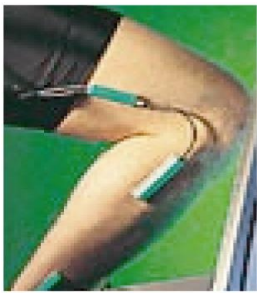


Figure 3

4.2.3 Connection of endblocks to display unit and operation check

Attach the interconnect lead to the colored (green) output leads (black wires extending from the upper endblock) and to the display unit.

- Connect the black socket of the interconnect lead to the black plug of the output connector ensuring that the two red polarity marks are aligned.

- Connect the silver plug of the interconnect lead to either input socket on the display unit. Ensure that the red polarity dots are aligned and push the plug until it engages with a click. The plug itself is of a self-latching type and cannot be disconnected by pulling on the cable. (To remove the plug, hold the outer case and pull until it disengages.)

- Turn on the display unit. The green light will indicate which channel is currently being displayed on the LCD.

4.2.4 Explaining the test procedure to the participant and practice trials

- With the participant's leg dangling, set the display to "0."

  Ask the participant to very slowly extend the knee being examined as straight as they can. Record the goniometer angle from the display unit on the data collection form. It should be between about 51 to 70,° but may be as great as 90.° If the angle is not between 51 and 90,° make one attempt to reposition but proceed anyway with the testing even if the angle continues to be less than 51.°

- Tell the participant to relax the leg.

  Script: "Very slowly straighten your leg until your knee is as straight as possible. Good. *(Record angle.)* Now relax your leg. Great. Everything is working. Now we're ready to practice."

When the goniometer is in place, the examiner explains and demonstrates the testing procedure to the participant, then performs two practice trials.

- Have the participant do two practice trials with eyes closed and tray blocking their vision of their legs.

- Tell them to slowly straighten their leg until the display unit indicates a knee angle in the range indicated on the form for the practice trials. Ask them to stop and hold their leg in that position for about 5 seconds (examiner counts to 5), then relax and drop the leg back down. After about three seconds, ask them to go back to that position and hold it for a few seconds. (Note: the first suggested angle for practice is 30-40° and the second is 15-25.°)

- If the participant does not seem to understand, explain it again. If they do not understand after the second attempt, do not do the test on that person. Mark "Not Attempted/Unable" on the data collection form.

  Detailed instructions to participant

  "Let me show you a couple of times how to do this test. For each test, I'll have you stop when your knee is bent to a slightly different angle.

Script: "Slowly raise your leg. . . STOP. . . hold it and remember this position (*Record the test angle).* Relax. (*Wait 3 seconds.)* Repeat the position. *(Record the reproduced angle.)* Relax." *(Repeat for the second practice trial.)*

(After practice trials) "Good. I think you've got it. Do you have any questions?

"We'll do the test 10 times with your knee in a different position for each test."

4.3 Examination

The examination consists of 10 trials on the dominant knee. Participants are asked to reproduce angles falling between five ranges according to a preset order indicated on the data entry form:

1. between 35 and 45°
2. between 15 and 25°
3. greater than 45°
4. between 5 and 15°
5. between 25 and 35°
6. between 15 and 25°
7. between 35 and 45°
8. between 5 and 15°
9. greater than 45°
10. between 25 and 35°

4.3.1 Test the dominant leg

The participant remains sitting with the back of the knees just touching the examination table and their lower legs relaxed and dangling down freely. The examiner sits facing the participant slightly to the side of the leg that is being tested so its movement isn't restricted by the examiner.

- Ask the participant to close their eyes. Place the tray to block the participant's view of their legs.

- Ask the participant to slowly straighten their leg. You can gently limit the range of motion to be within the desired parameters by lightly touching the participant's heel and/or the top of their foot or tips of their toes as they straighten their leg, although most participants will be able to stop straightening their leg when you tell them to. When the angle on the display unit reaches a value in the range specified for the trial, have the participant hold their leg at that position, as steady as possible, for about 5 seconds (examiner can silently count to five).

- Record the angle seen on the display unit as the ***test angle***. If the angle is not held steadily for about 5 seconds, record the value held the longest. The reading does tend to vary a bit with movement. If the value drifts by more than 3,° record the high and low value (the median value will be calculated after the data collection form has been scanned). Then tell the participant to relax their leg to the freely dangling position.

Note that if the test angle is greater than 5 degrees from the suggested range (e.g., the examiner inadvertently stops the participant from moving their leg too soon or lets the participant move their leg too far) that the participant should be asked to rest and the test angle should be done again.

- After about 3 seconds, ask the participant to straighten their knee again to the angle they were just at and hold there for about 3 seconds while the goniometer registers the angle, then relax the knee.

- Record the angle they attain or hold the longest during the 3 seconds. This measure will be recorded as the ***reproduced angle***. If the value drifts by more than 3, record the high and low value (the median value will be calculated later after the data is scanned.)

- It is important to encourage the participant to relax their leg between trials. If the goniometer reading at rest is greater than 5 degrees, ask the participant to relax so the angle is as close to 0 as possible. If they don't relax, ask them again; then proceed.

  Script: "Slowly raise your leg. . . STOP. . . hold it and remember this position (*Record the test angle).* Relax. (*Wait 3 seconds.)* Repeat the position. *(Record the reproduced angle.)* Relax."

  Repeat for the remaining trials.

- Repeat this procedure nine times using the knee angles specified on the form. Rests between trials can be taken as needed, but do not allow a rest between the test and reproduced angle. Participants should be told to report if they lose concentration or forget a position so that the test position can be repeated and they don't begin guessing. Give LOTS of encouragement and positive reinforcement, regardless of how they are doing on the test. Do NOT give any indication of how well or poorly they are doing. If the leg is moved too rapidly to stop it at the specified angle, remind them to straighten their knee "very slowly" and repeat the trial. Ask the participant if they need a rest after they have completed five trials.

4.3.2 End of examination

- Turn off the display unit.

- Disconnect wires from endblocks. Remove endblocks from participants. Warn them it may hurt a bit as you remove the tape. Clean off pen marks on skin with an alcohol swab.

- Take the tape off the endblocks.

  Script: "That was excellent. Thanks very much for helping us with that."

5. Alert values/follow-up/reporting to participants

There are no alert values. When the testing is completed, thank the participant.

6. Quality assurance

6.1 Training requirements

No special qualifications or experience are required to perform this assessment. Training should include:

- Read and study manual
- Attend MOST training session on techniques (or observe administration by experienced examiner)
- Practice on other staff or volunteers
- Compare measurements with those made by experienced colleagues (Goal: obtain measurements within 1 degree of experienced colleague).
- Discuss problems and questions with local expert or QC officer

6.2 Certification requirements

- Complete training requirements
- Demonstrate proper use and care of goniometer
- Conduct exam on two volunteers:

  - According to protocol, as demonstrated by completed QC checklist

  - Endblocks placed correctly

  - Test angles within range
  -< ± 1 degree difference between examiner to be certified and local expert or QC officer on any of the angles measured (test angle/reproduced angle).

6.3 Quality assurance checklist

Preparation

- ☐ Participant in proper attire

Preparation for test

- ☐ Participant sitting at edge of exam table with legs freely dangling
- ☐ Correct determination of which leg to test
- ☐ Foam wedge properly placed under participant's thigh
- ☐ Four-inch straight line marked just below head of fibula out toward lateral malleolus
- ☐ Four-inch straight line marked just above lateral epicondyle of femur out towards greater trochanter, approximately parallel with table
- ☐ Lower endblock placed just below head of fibula in line with lateral malleolus
- ☐ Upper endblock placed on outer side of thigh, just above lateral epicondyle of femur
- ☐ Endblocks correctly fastened to participant's leg

- ☐ If extra tape is used, recorded on data collection form
- ☐ Participant's leg moved through flexion and extension to ensure spring wire between endblocks didn't kink or touch the table, and repositioned, if necessary
- ☐ Black socket of interconnect lead connected to black plug of sensor
- ☐ Silver plug of interconnect lead connected to either input socket on display unit, with red dots aligned
- ☐ Display set to zero with participant's leg freely dangling and knee at 90˚
- ☐ Leg extended and knee straightened as much as possible, angle recorded

Examination

- ☐ Instructions properly given to participant
- ☐ Script adhered to and key points delivered clearly
- ☐ Participant's eyes closed during the examination and tray in place
- ☐ Participant held dominant leg steady for 5 seconds
- ☐ Test angles within required range
- ☐ Test angle recorded correctly on data collection form (or highest/lowest angles if participant didn't hold for at least 3 seconds)
- ☐ Participant asked to reproduce angle for 3 seconds
- ☐ Reproduced angle recorded on data collection form (or highest/lowest angles if participant didn't hold for at least 3 seconds)
- ☐ Test repeated 10 times using suggested angles after two practices
- ☐ Participant asked if they are tired and need a break between tests, never between angle and reproduced angle measurement
- ☐ Participant asked if they need a break after five trials
- ☐ Display turned off before interconnect leads removed from endblocks
- ☐ Cleaned off pen marks on skin with an alcohol swab

End of test

- ☐ Reviewed form for completeness
- ☐ Correctly completed form

7. Data collection form

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Proprioception

MOST ID #	Acrostic	Date Form Completed	Staff ID#
Office Use Only		Month / Day / Year	

1. Which foot do you or did you prefer to kick a ball with?

○ Right foot	○ Left foot	○ Don't know/Refused
Attach electrogoniometer to right leg.	Attach electrogoniometer to left leg.	Attach electrogoniometer to right leg.

2. Angle from leg dangling (0°) to full knee extension: ☐☐ °

3. Was additional tape used to attach the endblocks?

○ Yes ○ No ○ Refused

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Proprioception
(cont.)

MOST ID #	Acrostic	Date Form Completed	Staff ID#
Office Use Only		Month / Day / Year	

4 Which leg is being tested?

○ Right leg ○ Left leg

Practice Sessions	Test Angle (5 sec)		Reproduced Angle (3 sec)		Refused	Not Attempted/ Unable	Attempted, unable to complete
	Angle held longest (OR if much drift: record low value of range.)	(If much drift: record high value of range.)	Angle held longest (OR if much drift: record low value of range.)	(If much drift: record high value of range.)			
1 (30-40°)					○	○	○
2 (15-25°)					○	○	○
Test Sessions							
1 (35-45°)	°	°	°	°	○	○	○
2 (15-25°)	°	°	°	°	○	○	○
3 (>45°)	°	°	°	°	○	○	○
4 (5-15°)	°	°	°	°	○	○	○
5 (25-35°)	°	°	°	°	○	○	○
6 (15-25°)	°	°	°	°	○	○	○
7 (35-45°)	°	°	°	°	○	○	○
8 (5-15°)	°	°	°	°	○	○	○
9 (> 45°)	°	°	°	°	○	○	○
10 (25-35°)	°	°	°	°	○	○	○