KLT
Knee Laxity Tester
For Instrumented Stability Testing of the Knee Joint
KLT

Knee Laxity Tester for instrumented stability testing of the knee joint

Injuries of the anterior cruciate ligament (ACL) and/or posterior cruciate ligament (PCL) are confirmed by the anterior and posterior drawer tests.

Problems and shortcomings of clinical examinations

In the clinical examination, increased tibial translation (drawer) in side-to-side comparison suggests injury to the cruciate ligament. The character of the end feel is assessed as well. In case of firm end feel, parts of the cruciate ligament are still intact, while a soft end feel indicates that the patient no longer has sufficient ligament structures.

In addition to determining the end feel, the examiner attempts to quantitatively assess the extent of tibial translation. Three grades are commonly used for classification:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Character</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>+</td>
<td>1-5 mm</td>
</tr>
<tr>
<td>II</td>
<td>++</td>
<td>6-10 mm</td>
</tr>
<tr>
<td>III</td>
<td>+++</td>
<td>&gt; 10 mm</td>
</tr>
</tbody>
</table>

Concerning this clinical quantification, it is worth noting that each examiner applies a different amount of force to trigger tibial translation. In addition, differences in the angle of flexion and the individual soft tissue layer as well as the patient’s muscle tension must be taken into account.

Instrumented laxity measurement

Instrumented stability measurement with a test device allows the exact and reproducible determination of tibial movement.

Studies have shown that quantifying the extent of tibial translation using a test device is far superior to clinical examination. Numerous test devices have therefore been developed in recent years. However, they exhibit numerous deficits in clinical use:

- Time-consuming examination
- Tendency to tip due to unstable fixation
- Difficult examination procedure
- Imprecise or complicated calibration procedure
- High measurement inaccuracy
- Poor or inexact readability of measurement values
- High purchase price
Knee Laxity Tester – KLT

The Knee Laxity Tester (KLT) was developed to allow fast, straightforward, and reproducible instrumented stability testing. It meets the requirements for quantifying the drawer movement. The tester offers the following advantages:

- Practical
- Easy to use
- Rapid and easy fixation
- Rapid and easy calibration
- Exact measurement process
- High accuracy (+/- 0.1 mm)
- Rapid measurement process
- Wide range of tests

The Knee Laxity Tester (KLT) features a simple and clear design:

1. Velcro strap
2. Tibia pad
3. Body of device
4. Measuring plunger
4a. Adjustment screw for adjusting the sliding resistance of the measuring plunger
5. Lock button / transport lock for locking the measuring plunger in the resting position
5a. User interface
5b. Measurement display
5c. Calibration button
6. ON/OFF button
7. Joint line mark on device
8. Patella pad
The instrument

Range of tests

Four important clinical tests can be performed with the KLT:

1. Lachman test
2. Spontaneous posterior drawer test in 90° flexion
3. Fixed posterior drawer test
4. Anterior drawer test in 90° flexion

Note: All tests are always performed in comparison with the other leg to determine the side-to-side difference (SSD).
How to perform the Lachman test

The Lachman test is the most important clinical test in acute and chronic anterior cruciate ligament lesions. Since this test cannot exactly determine the extent of tibial translation, quantification with the KLT is recommended.

Note: The exam starts with the healthy knee to allow the patient to become used to the procedure.

1. Marking the joint line

The patient is positioned supine on the examination table. At about 90° flexion, mark the medial joint line on both knees (Fig. 2).

2. Positioning

As is the case when performing the clinical Lachman test (stable Lachman test), the examiner places their bent knee below the patient’s distal thigh, which then rests relaxed on the examiner’s thigh (Fig. 3).

3. Placing the KLT and fixing it in place

Set the KLT on the anterior aspect of the lower leg, with the KLT’s joint line mark lining up with the marked joint line (Fig. 4). Wrap the Velcro strap around the lower leg and fix it in place on the KLT’s tibia pad. In the process, hold the KLT’s patella pad in place with one hand.

Fig. 2: Marking the joint line  Fig. 3: Positioning the patient’s leg  Fig. 4: Fixing the KLT in place on the lower leg
4. Switching on and calibrating

Press the ON/OFF button to turn on the KLT (Fig. 5a). Then unlock the measuring plunger by pressing the unlock button and push it on the tibial tubercle (Fig. 5b). The display shows a negative value since the measuring plunger is moved from the resting position.

**Note:** When switching on the KLT and during calibration, the examiner holds the patella pad in place with one hand.

The KLT is calibrated by pressing the calibration button, and the value 0.0 mm appears on the display (Fig. 5c).

**Note:** If it is difficult to advance the measuring plunger (see Figs. 1a, b), loosen the adjustment screw (see Figs. 1a, b). If the measuring plunger can be moved very easily or even without any resistance at all, slightly tighten the adjustment screw.

5. Test

First, ensure that the patient is relaxed. The patient should not lift their head from the examination table since this leads to reflex muscle tension and hence distinctly reduces the drawer sign. With the free hand, grasp the posterior aspect of the patient’s proximal lower leg, and pull it forward in a controlled, sudden and firm movement (Fig. 6a).

The extent of anterior tibial translation (anterior drawer) is shown on the measurement display since the measuring plunger remains slid in (Fig. 6b).

**Note:** If the measuring plunger is hard to move, loosen the adjustment screw. In contrast, if it spontaneously slides back onto the tibial tubercle, slightly tighten the adjustment screw. Ideally, the measuring plunger should always be advanced and retracted against some sliding resistance to ensure that it remains in the maximum position and the measured value is shown in this position.
Repeating the test

Press the measuring plunger onto the tibial tubercle once again. Ideally, the measured value is close to 0.0 mm (range of $-0.5$ to $+0.5$ mm) (Fig. 6c) In that case, the calibration button does not need to be pressed.

If the displayed value deviates from the 0.0 mm range ($-0.5$ through $+0.5$ mm), a negative or positive value appears.

a. **Negative value (< -0.5 mm):**

A negative value appearing after the measuring plunger is pushed back (< -0.5 mm) suggests that the patient relaxed his/her muscles better after the start of the test. To calibrate the KLT, press the calibration button and repeat the test.

b. **Positive value (> +0.5 mm):**

A positive result (> +0.5 mm) indicates that the patient has tensed their muscles. The lower leg does not sag to the original position. In that case, ask the patient to relax. Ensure that the patient does not lift their head from the examination table (muscle tension). Press the calibration button again and repeat the test.

The Lachman test is repeated three times. The mean of the measured values equals the Lachman test result (near-extension drawer).

6. **Determining the side-to-side difference (SSD)**

After examining the healthy knee joint, perform the same procedure on the injured knee. The difference between the two drawer values equals the SSD.

At the end of the examination, retract the measuring plunger until the lock button engages, and switch off the KLT.
How to perform the spontaneous posterior drawer test in 90° flexion

In the clinical examination, spontaneous posterior drawer must be ruled out by inspecting the tibial tubercle in side-to-side comparison, with the knee joint in 90° flexion. One side sagging indicates spontaneous posterior drawer, provided that osseous changes associated with prominence of the tibial tubercle (e.g., Osgood-Schlatter disease) have been ruled out. Alternatively, the posterior drawer palpation test can determine whether the head of the tibia has sunk downward. If spontaneous posterior drawer is suspected, quantification is recommended. No test devices were previously available for this purpose, but with the KLT, the extent of spontaneous posterior drawer can be easily and reproducibly measured.

1. Marking the joint line

Bilaterally mark the medial joint line (see Fig. 2 for the procedure).

2. Positioning

The patient is positioned supine on the examination table, with both knees in exactly 90° flexion.

Note: Ensure that the angle of flexion is identical for both knees.

3. Placing the KLT and fixing it in place

Place the KLT on the anterior aspect of the intact lower leg, with the knee in 90° flexion. The joint line mark at the KLT is lined up with the joint line (Fig. 7).

Hold the KLT’s patella pad in place with one hand. The KLT does not need to be further stabilized since it rests on the lower leg with its own weight (Fig. 7).

4. Switching on and calibrating

Switch on the KLT (see Fig. 5a), unlock the measuring plunger, and press it on the tibial tubercle (see Fig. 5b). The display shows a negative value since the measuring plunger is moved from the resting position (see Fig. 5b).

Note: The examiner holds the KLT’s patella pad in place with one hand when switching the device on and during calibration.

The KLT is calibrated by pressing the calibration button, and the value 0.0 mm appears on the display (Fig. 8).
5. Test

Without tilting the KLT or moving the measuring plunger, remove the KLT from the lower leg of the intact side and place it on the injured leg. The display first shows the reference value (0.0 mm) of the intact joint (Fig. 9a).

Note: If the measuring plunger slides further out without applying force, slightly tighten the adjustment screw to increase the sliding resistance of the measuring plunger. Ideally, the measuring plunger should be advanced and retracted against slight sliding resistance.

To test for spontaneous posterior drawer, carefully push the measuring plunger on the tibial tubercle. A negative measurement, e.g., -7.4 mm, indicates the extent of spontaneous posterior drawer (Fig. 9b).

Then return the KLT from the injured to the healthy leg, with the measuring plunger being slid back in by the tibial tubercle, which did not sag. The negative value drops and approaches 0.0 mm (Fig. 10).

If the value deviates by more than 0.5 mm from the measured spontaneous posterior drawer value of the injured side, press the calibration button (see Fig. 5c) so that the value 0.0 mm reappears on the measuring scale (see Fig. 8).

After the calibration process, place the KLT on the injured side again and press the measuring plunger on the tibial tubercle (see Fig. 9b).

The spontaneous posterior drawer value, which should only minimally deviate from the initially measured posterior drawer (see Fig. 9b), is displayed again (Fig. 11).
The test is repeated three times. The mean of the measurements equals the extent of spontaneous posterior drawer.

**Note:** In the clinical examination for spontaneous posterior drawer, no force or merely the KLT’s own weight is applied to the tibia. The extent of spontaneous posterior drawer is therefore often much smaller than the extent of posterior tibial translation indicated in stress radiographs since they provoke the posterior drawer sign by applying much greater force (15 or 20 kp).

At the end of the examination, retract the measuring plunger until the lock button engages, and switch off the KLT (press the ON/OFF button).

---

**How to exclude fixed posterior drawer**

To date, fixed posterior drawer was ruled out by taking stress radiographs in 90° flexion under anterior drawer stress. This test can also be performed with the KLT, however. First the extent of spontaneous posterior drawer is determined (see procedure above).

1. **Marking the joint line**
   Bilaterally mark the medial joint line (see Fig. 2 for the procedure).

2. **Positioning**
   The patient is positioned supine on the examination table, with both knees in exactly 90° flexion.

   **Note:** Ensure that the angle of flexion is identical for both knees.
3. Placing the KLT and fixing it in place

Place the KLT on the anterior lower leg of the intact side, with the knee in 90° flexion. The joint line mark at the KLT is lined up with the joint line (see Fig. 7). The examiner additionally holds the KLT in place at the patella pad (see Fig. 8).

4. Switching on and calibrating

Switch on the KLT, which is placed on the healthy side, unlock the measuring plunger, and press it on the tibial tubercle. The KLT is calibrated by pressing the calibration button, and the value 0.0 mm appears on the display (Fig. 8).

5. Test

5.1 Spontaneous posterior drawer test

Without tilting the KLT or moving the measuring plunger, remove the KLT from the intact side and place it on the injured leg. The display shows the reference value (0.0 mm) of the intact side (Fig. 9a).

*Note:* In this case, the KLT is fixed in place on the distal lower leg with the Velcro strap, which is not done when only testing for spontaneous posterior drawer (Fig. 12).

To identify spontaneous posterior drawer, push the measuring plunger on the tibial tubercle. The display shows the extent of spontaneous posterior drawer, e.g., -14.7 mm (Fig. 13).

5.2 Provoking the anterior drawer sign

Then pull the lower leg forward while holding the patella pad in place (Fig. 14).
If the lower leg remains in a posterior position, the value of spontaneous posterior drawer can only be minimally reduced, e.g., to -11 mm. Hence, the patient exhibits a fixed posterior drawer of -11 mm (see Fig. 14).

If the fixed posterior drawer sign is minor, the value approaches zero (Fig. 15a).

Ideally, the tibia can be moved far enough anteriorly from the posterior drawer position to result in a measurement value of 0.0 mm or even a small positive value (Fig. 15b). In that case, the patient does not exhibit a fixed posterior drawer sign.

The test is repeated three times. The mean of the measurements equals the extent of fixed posterior drawer, if present.

At the end of the examination, retract the measuring plunger until the lock button engages, and switch off the KLT.
How to perform the anterior drawer test in 90° flexion

The classic – but now rarely used – anterior drawer test is performed in 90° flexion. Due to the KLT’s small size and low weight, the extent of anterior drawer can be quantitatively determined in 90° flexion as well.

1. Marking the joint line
Bilaterally mark the medial joint line (see Fig. 2 for the procedure).

2. Positioning
The patient is positioned supine on the examination table, with both knees in exactly 90° flexion.

   Note: Ensure that the angle of flexion is identical for both knees.

3. Placing the KLT and fixing it in place
Place the KLT on the anterior lower leg in 90° flexion. The joint line mark at the KLT is lined up with the joint line (see Fig. 7).
Then use the Velcro strap to fix the KLT in place on the lower leg to prevent tilting. In addition, hold the KLT in place by placing your hand on the patella pad (see Fig. 12).

4. Switching on and calibrating
Switch on the positioned KLT, unlock the measuring plunger, and press it on the tibial tubercle (see Fig. 5). Calibrate the KLT by pressing the calibration button; the value 0.0 mm appears on the display (Fig. 8).

5. Test
In 90° flexion, pull the lower leg forward in a controlled manner (see Fig. 14). The display shows a positive value, indicating the extent of the anterior drawer (anterior tibial translation).
Push the measuring plunger back on the tibial tubercle. Ideally, the displayed value is between +0.5 mm and -0.5 mm. Otherwise, the KLT is recalibrated (see Lachman test above).
The test is repeated three times. The mean of the measurements equals the anterior drawer value.

   Note: If desired, anterior rotatory drawer (anterior drawer in various rotation positions) can be tested as well. Before provoking the drawer sign, the examiner firmly holds the patient’s foot in the desired internal rotation, neutral position, and external rotation by sitting on the rotated foot as is done in the clinical examination of rotatory drawer.

6. Determining the side-to-side difference (SSD)
The procedure for the injured leg is identical. The difference between the two drawer values equals the SSD.
At the end of the examination, retract the measuring plunger until the lock button engages, and switch off the KLT.
It is recommended to check the suitability of the product for the intended procedure prior to use.