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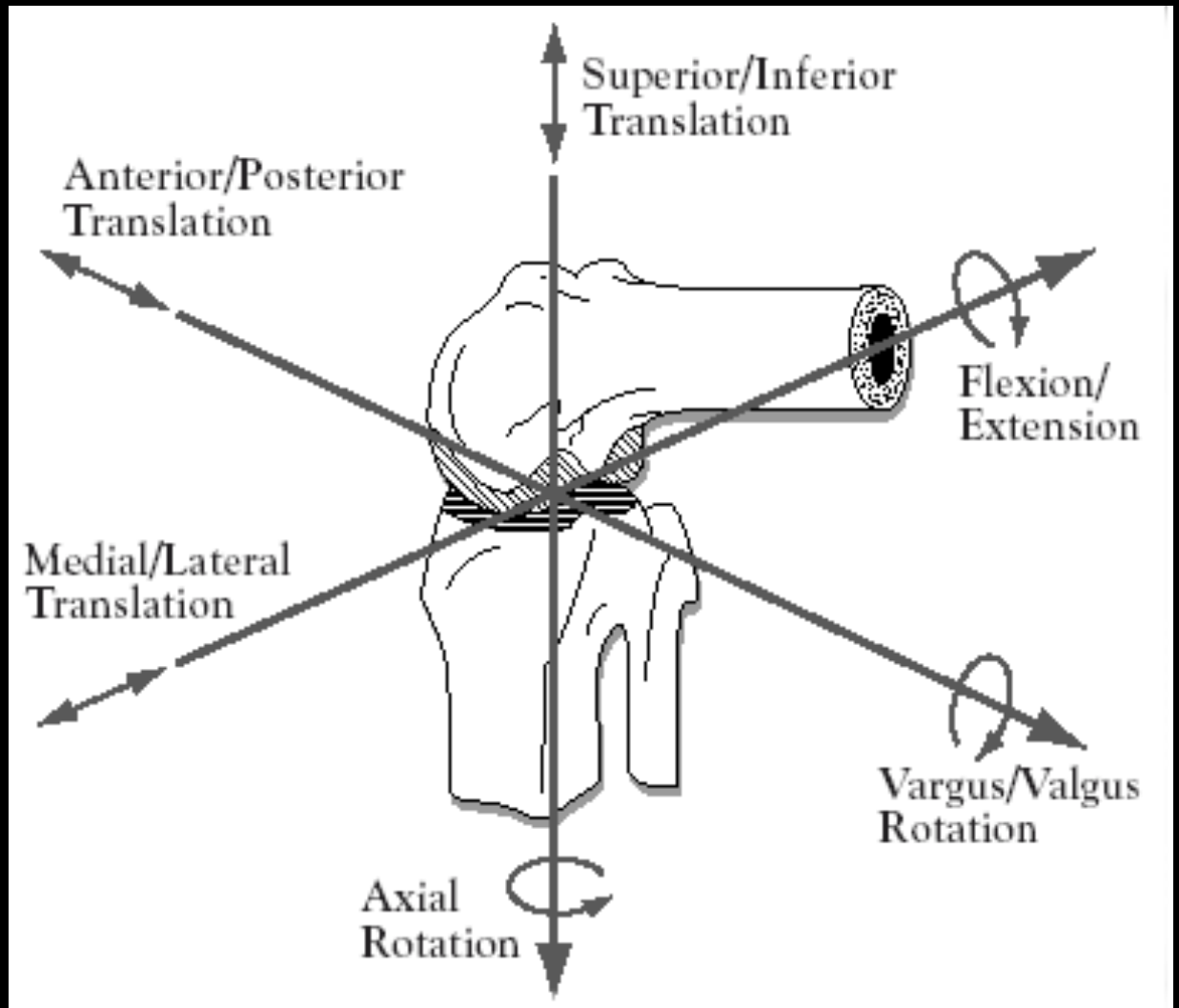


Six degrees of freedom of the knee joint, which include 3 rotational and 3 translational motions.

Ω Μ Ο Σ

Measurement of anterior-to-posterior translation of the glenohumeral joint using the KT-1000.
Pizzari T et al.L. J Orthop Sports Phys Ther 1999 Oct;29(10):602-608

Instrumented measurement of glenohumeral joint laxity and its relationship to passive range of motion and generalized joint laxity.
Sauers EL et al.Am J Sports Med 2001 Mar;29(2):143-150

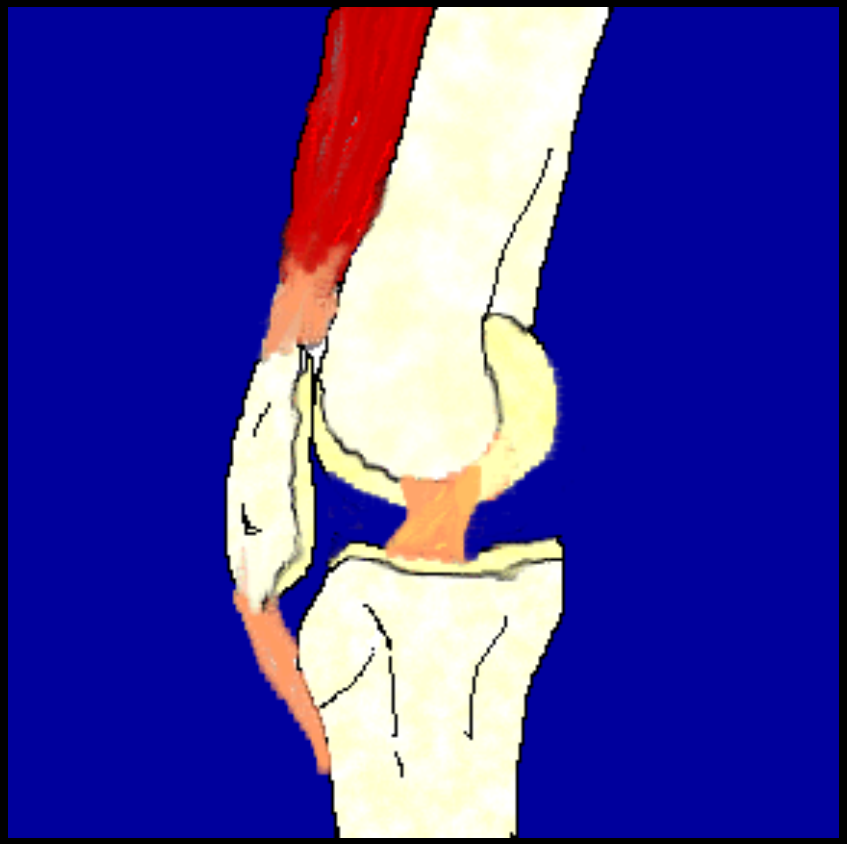
Π Ο Δ Ο Κ Ν Η Μ Ι Κ Η

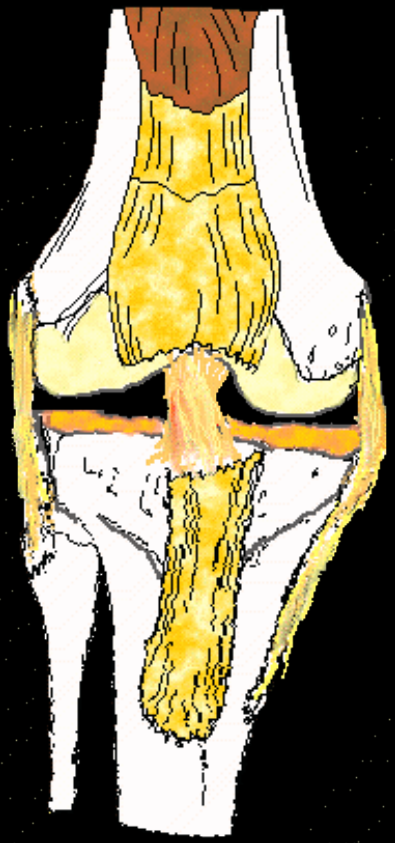
Quantitative measurement of ankle passive flexibility using an arthrometer on sprained ankles.
Liu W et al. Clin Biomech (Bristol, Avon) 2001 Mar;16(3):237-244

Ε Π Ι Μ Υ Ε Σ

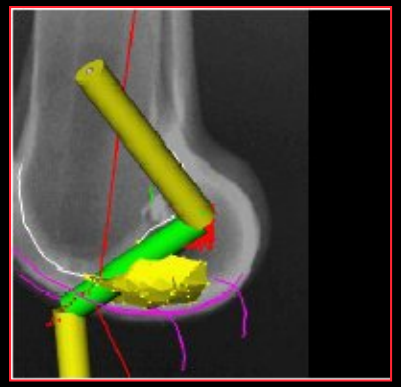
A mechanical arthrometer to measure knee joint contracture in rats.
Trudel G et al. LA. IEEE Trans Rehabil Eng 2000 Mar;8(1):149-155

Εμβιομηχανική ΠΧΣ



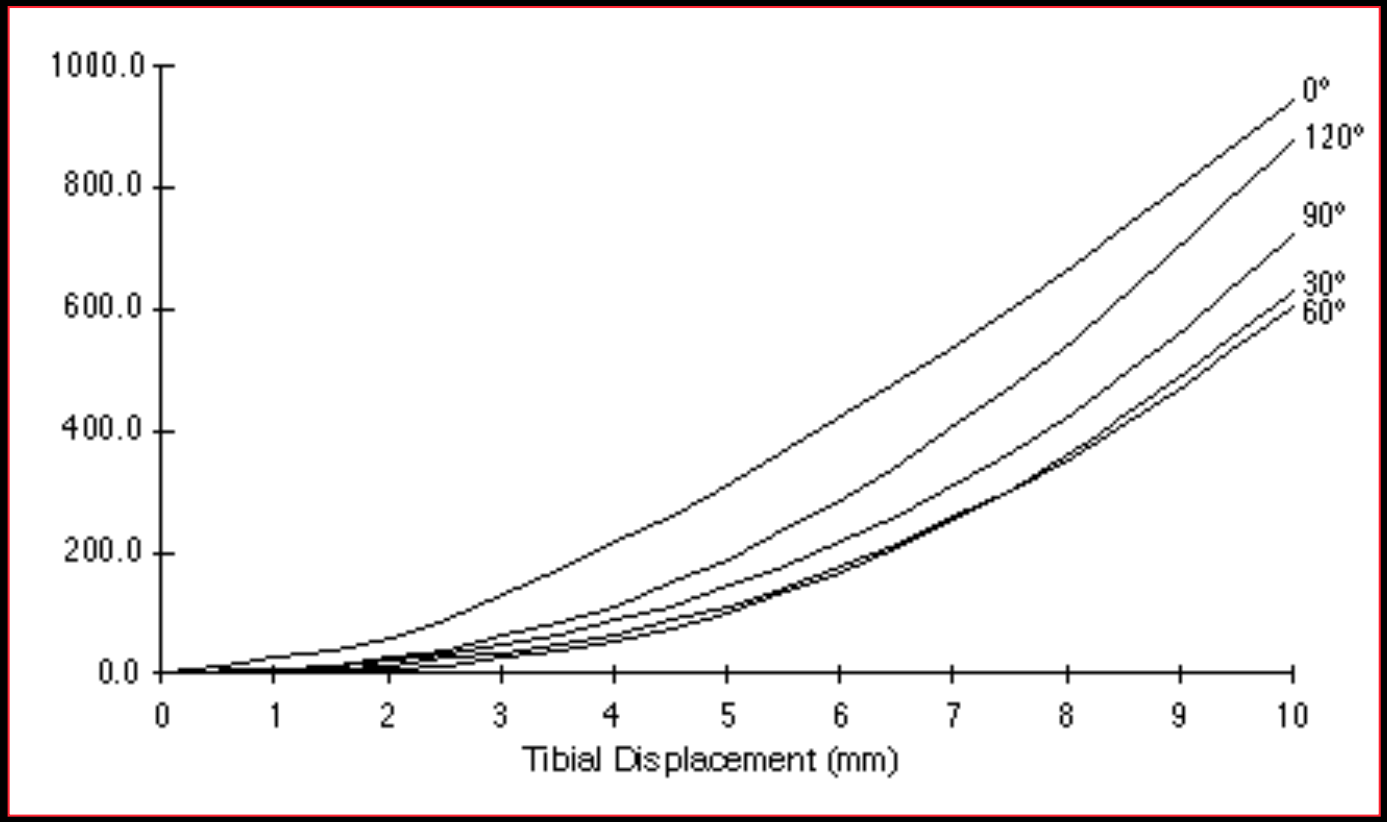


Εμβιομηχανική ΠΧΣ



- Ο ΠΧΣ παρεμποδίζει την προσθιοπαρεκτόπιση της κνήμης
- Δέχεται 75 % της δύναμης σε πλήρη έκταση
- Δέχεται το 85% της δύναμης σε 30^0 και 90^0

Η μηχανική συμπεριφορά του ΠΧΣ εξαρτάται από την κάμψη του γόνατος



COMPUTER SIMULATION STUDIES OF ACL LOADING MECHANICS

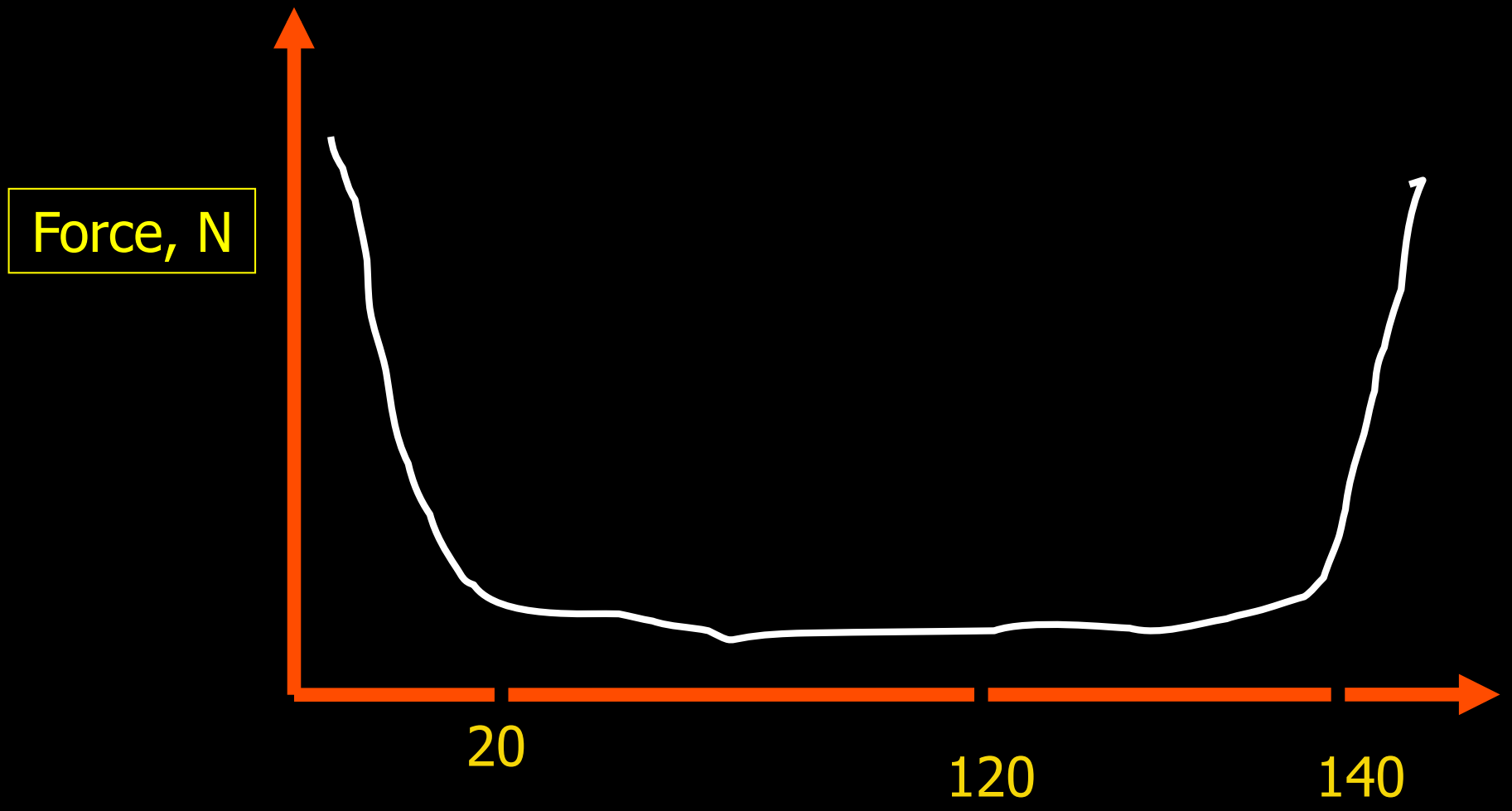
Steven J. Charlebois and Denis J. DiAngelo, ASB 1999

Ρόλος ΠΧΣ στη Βάδιση

- Ο ΠΧΣ είναι σε τάση στην πλήρη έκταση στρέφει την κνήμη προς τα έξω (screw home mechanism)

- Η τάση είναι ελάχιστη στις 40^0-50^0 κάμψης

Tension Pattern of the Intact ACL



Εμβιομηχανική ΠΧΣ

Μετά από διατομή του ΠΧΣ αντίσταση στην πρόσθια παρεκτόπιση προέρχεται από:

- Λαγονοκνημιαία

Ταινία: 24%

- Μέσο τμήμα έσω θυλάκου:

22%

- Μέσο τμήμα έξω θυλάκου:

20%

- ΕΠΣ: 16%

Εμβιομηχανική ΠΧΣ

- ✓ Σε φυσιολογικό ΠΧΣ σε ουδέτερη στροφή, εφαρμογή 100 N πρόσθιας δύναμης προκαλεί:

  2 – 5 mm πρόσθιας μετατόπισης σε πλήρη έκταση

  5-8 mm πρόσθιας μετατόπισης σε 30^0 κάμψης

- Αυξανομένης της κάμψης, μειώνεται η πρόσθια μετατόπιση
- Διατομή του ΠΧΣ αυξάνει τη μετατόπιση σε όλες τις γωνίες
- Σε γωνία κάμψης 20^0-30^0:
  Η μέγιστη πρόσθια παρεκτόπιση είναι 7-9 mm με δύναμη 100 N

repetitive loading exercise contributes to an increase in anterior translation in normal, anterior cruciate ligament-deficient, and anterior cruciate ligament-reconstructed knees, and the anterior cruciate ligament-reconstructed knee does not respond to repetitive loading in the same manner as a normal knee

The effect of exercise on anterior-posterior translation of the normal knee and knees with deficient or reconstructed anterior cruciate ligaments.

Kirkley A, Mohtadi N, Ogilvie R. Am J Sports Med 2001 May;29(3):311-314

Side-to-side differences using the manual maximum displacement test with the KT-1000 arthrometer revealed good correlation with the International Knee Documentation Committee

Comparison of score evaluations and instrumented measurement after anterior cruciate ligament reconstruction.

Hrubesch R et al. Am J Sports Med 2000 Nov;28(6):850-856

PHYSICAL EXAMINATION OF THE KNEE

LOOK

Whilst standing and walking - Skin- scars, redness
Muscle- wasting of quads (compare diameter of thigh if quads wasted)
Bone/joint- Effusion, Varus Valgus deformity(measure intermalleolar distance if valgus), Q angle - Remember to look in popliteal fossa - Knee & ankle positions (hamstring tightness) -Walking - look for varus thrust = collapse into more varus in stance loading (dynamic varus due to medial compartment OA or lateral lig. laxity)

FEEL

Skin - Temperature, back of hand - Muscle- Ask patient to contract quads
Bone/joint- Effusion fluid displacement test, patellar tap test (may be negative if tense effusion) - Synovial thickening - Joint line tenderness (with knee bent) - Femoral condyles (with knee bent) -Patellar tendon - MCL,LCL - Under patellar facets - Popliteal swellings

MOVE

Active then passive- Flexion (135 degrees normal) - Extension - Feel for crepitus

Δ Ι Α Γ Ν Ω Σ Η Ρ Η Ξ Η Σ
Π Χ Σ

- ✓ Ιστορικό
- ✓ Κλινική Εξέταση
- ✓ Αρθρομετρία
- ✓ Stress X-ray
- ✓ US
- ✓ MRI
- ✓ Αρθροσκόπηση και EUA

ACL Injury

1. Twisting injury to knee with pop.
2. Pain and immediate swelling.
3. The giving way of the knee with pivoting.
4. The patient demonstrates the '2 fist ' sign, indicating the sensation of the knee coming apart.

Classifications of Ligament Injury / Laxity Testing:

O'Donaghue:

First Degree Sprain ligament injury with no instability
Second Degree Sprain partial tear with some laxity
Third Degree Sprain complete tear with marked instability

Noyes:

Grade 1 0-5mm
Grade 2 6-10mm
Grade 3 11-15mm
Grade 4 16-20mm

Classification of knee joint instability resulting from ligament injury:

I. One-plane instability (simple or straight)
- A. One plane medial
- B. One plane lateral
- C. One plan posterior
- D. One plane anterior

II. Rotary instability
- A. Anteromedial
- B. Anterolateral
  1. In flexion
  2. Approaching extension
- C. Posterolateral
- D. Posteromedial

III. Combined instability
- A. Anterolateral-anteromedial rotary
- B. Anterolateral-posterolateral rotary
- C. Anteromedial-posteromedial rotary

The Physical Examination - ACL INJURIES

The Lachman Test (the main clinical examination test)

Pivot Shift Test

Range of Motion

Swelling
(in 75% of cases of hemarthrosis, an ACL tear is responsible.

ΠΟΣΟΤΙΚΗ ΜΕΤΡΗΣΗ ΤΗΣ ΠΡΟΣΘΙΑΣ ΠΑΡΕΚΤΟΠΙΣΗΣ ΤΗΣ ΚΝΗΜΗΣ

- Σημείο Lachman-Noulis
- Ακτινολογικές Μέθοδοι (δυναμικές ακτινογραφίες, ακτινοστερεομετρία)
- Electromagnetic Sensing Device (EMS) measurements
- Αρθρόμετρα

ΚΛΙΝΙΚΗ ΕΞΕΤΑΣΗ

- ✓ Σημείο Lachman-Noulis

- ✓ Φαινόμενο pivot shift

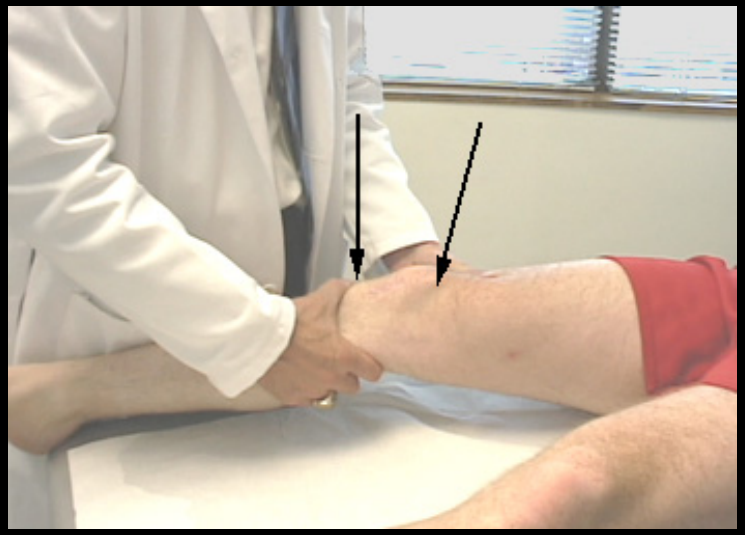
- Μεγάλη αξιοπιστία σε έμπειρους εξεταστές
- Μικρή επαναληψιμότητα της ποσοτικής εκτίμησης

ΠΟΣΟΤΙΚΗ ΜΕΤΡΗΣΗ ΤΗΣ ΠΡΟΣΘΙΑΣ ΠΑΡΕΚΤΟΠΙΣΗΣ ΤΗΣ ΚΝΗΜΗΣ

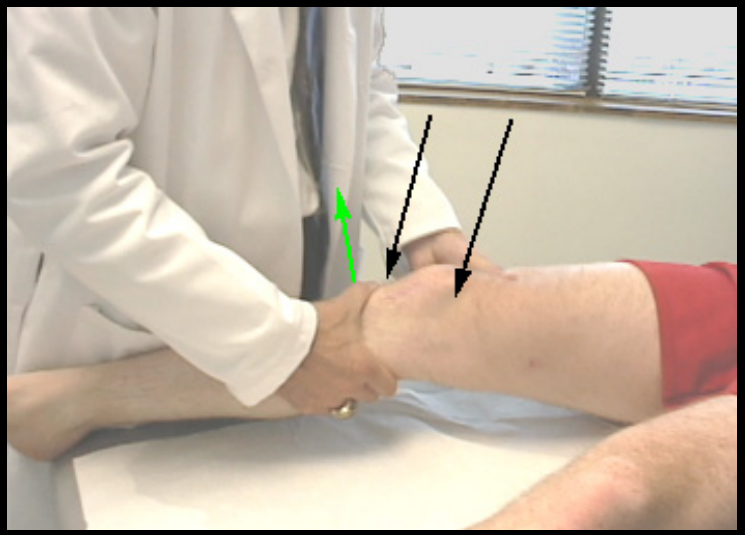
Ακτινολογικές Μέθοδοι

- ✓ Δυναμικές Ακτινογραφίες
- ✓ Ακτινοστερεομετρία
  - Εξαιρετική ακρίβεια
  - Τεχνικά δυσχερής η εκτέλεσή τους
  - Έκθεση σε ιονίζουσα ακτινοβολία
  - Ανάγκη ειδικού εξοπλισμού

Lachman-Noulis Test

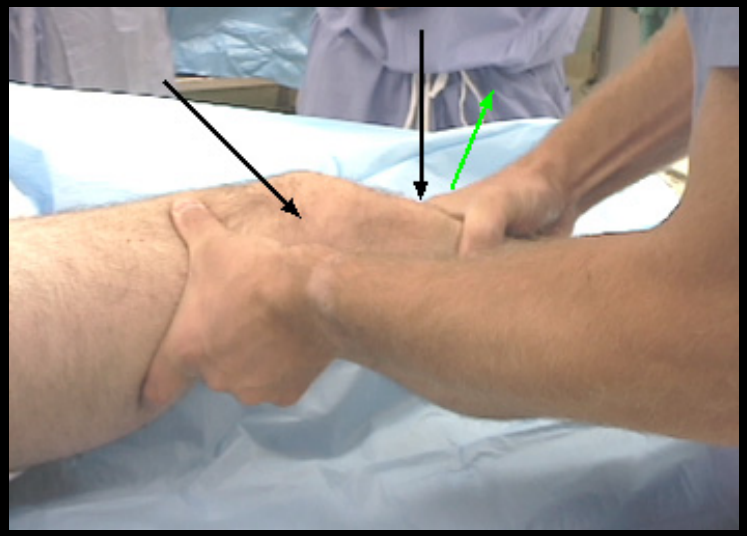


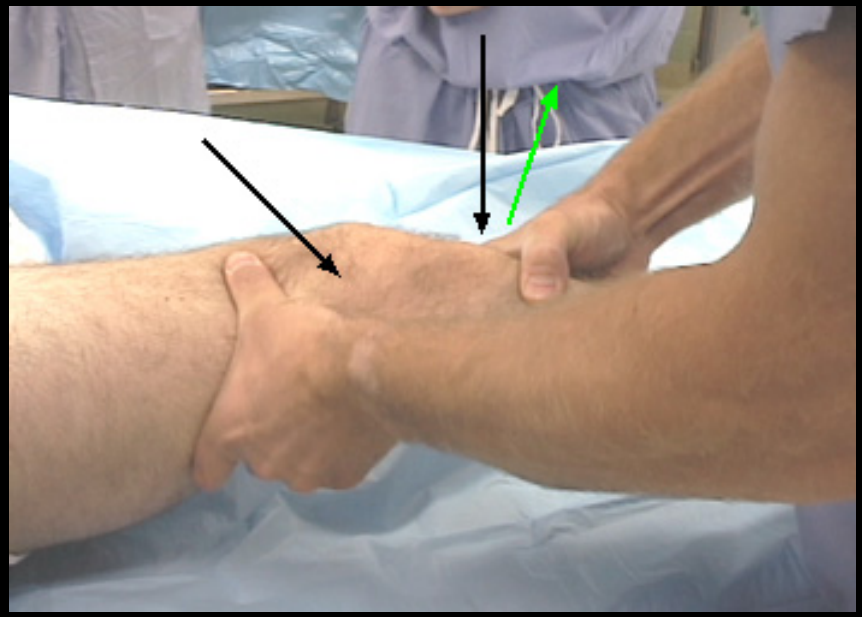
One hand secures and stabilizes the distal femur while the other firmly grasps the proximal tibia



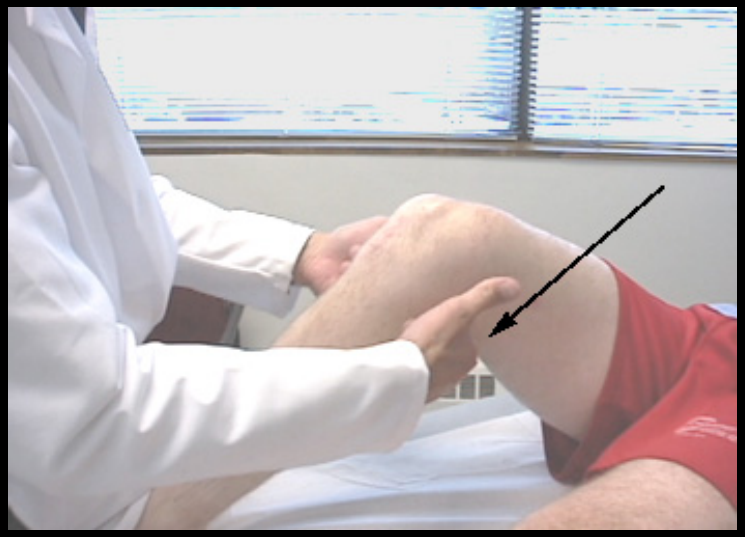
A gentle anterior translation force is applied to the proximal tibia.

The examiner assesses for a firm / solid or soft endpoint.

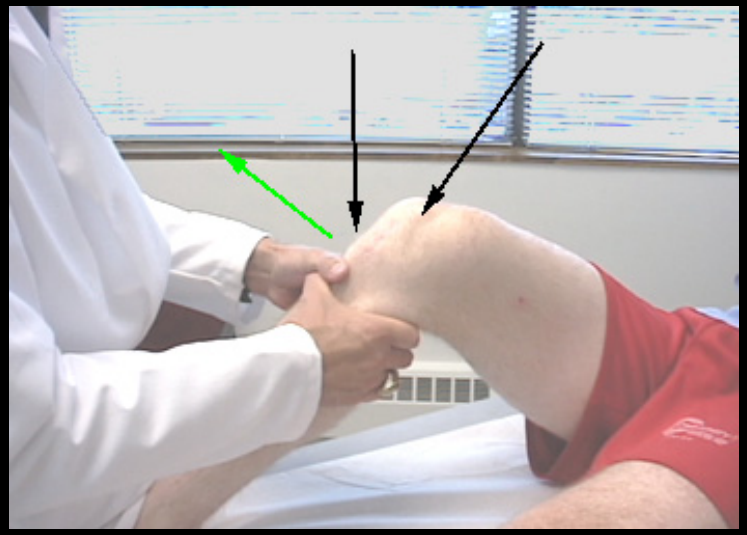




Anterior Drawer

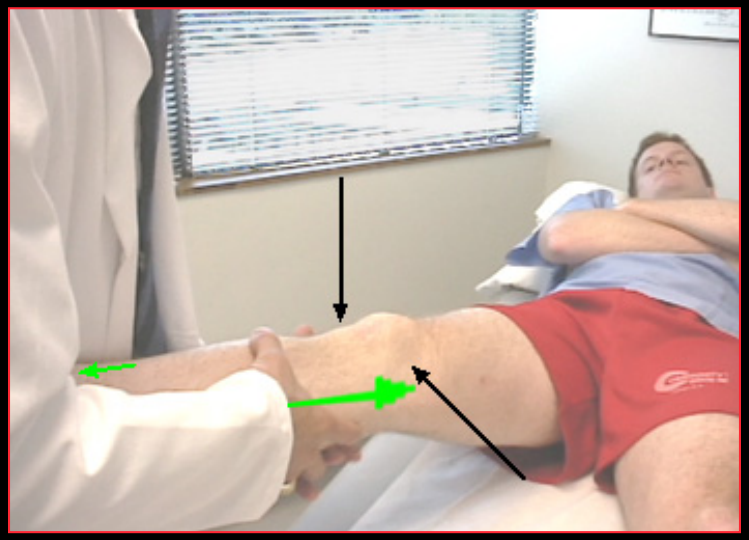


With the knee flexed to approximately 80° verification of complete relaxation of the hamstrings is achieved by hamstring palpation.

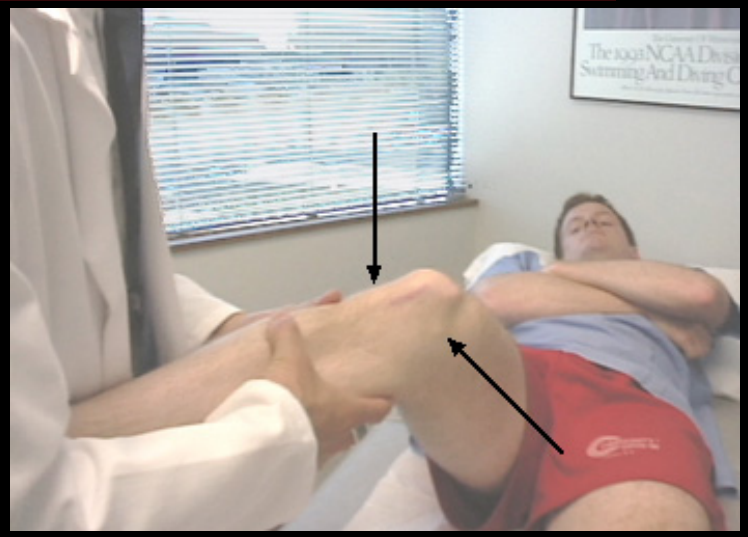


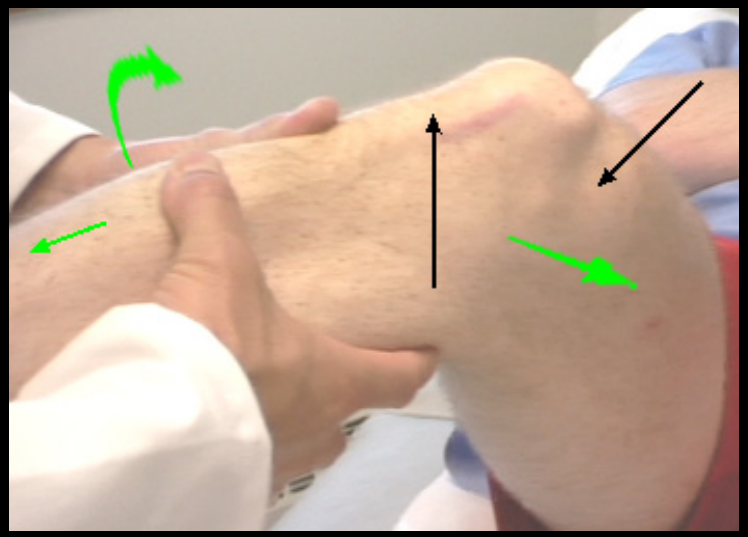
With the foot stabilized and in neutral rotation, a firm, but gentle, grip on the proximal tibia is achieved. An anterior force is then applied to the proximal tibia with a gentle to-and-fro motion to assess for increased translation compared to the normal contralateral knee.

PIVOT SHIFT TEST

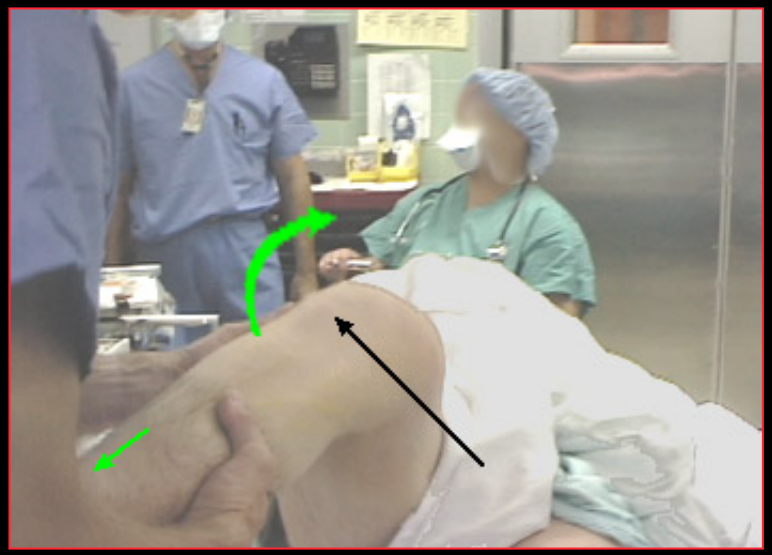


With slight distal traction on the leg, a valgus and internal rotation force is applied to the extended knee

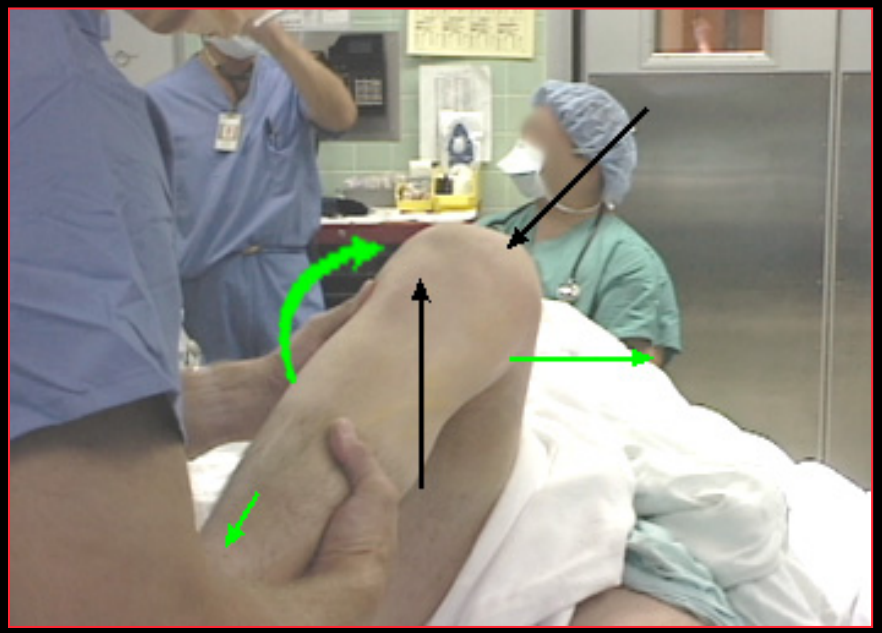




With maintenance of the forces noted above, the knee is then flexed past 30°.



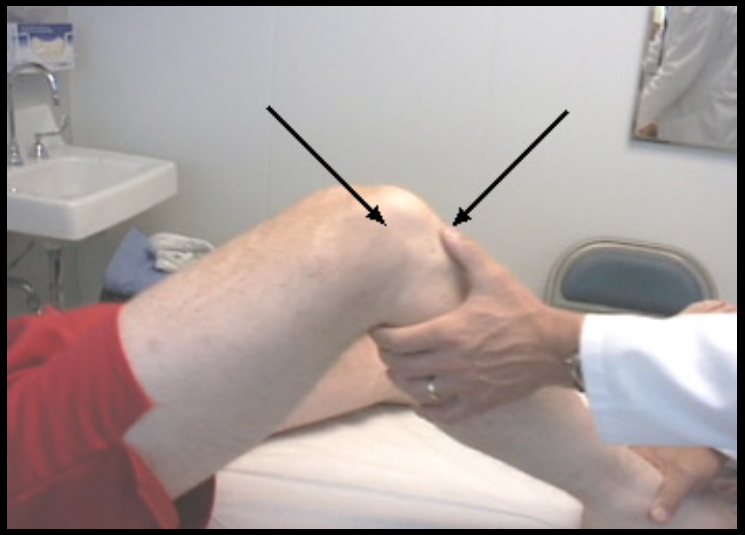
Pivot shift test in an ACL deficient knee. In the initial stages of knee flexion, the tibia will be anterolaterally subluxed on the distal femur with application of a valgus and internal rotation force at the knee.



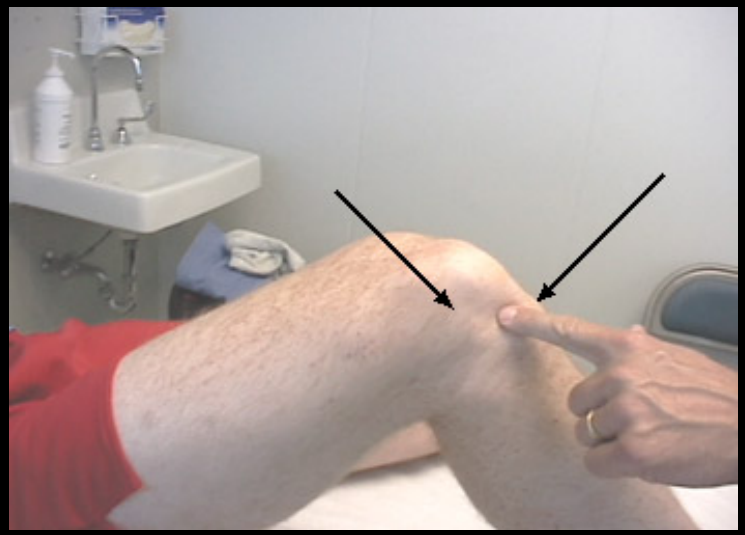
With further flexion of the knee (past approximately 30°), the iliotibial band goes from an extensor to a flexor of the knee and the tibial anterolateral subluxation reduces (shifts) back into place.

PIVOT SHIFT TEST

Tibial Drop Back



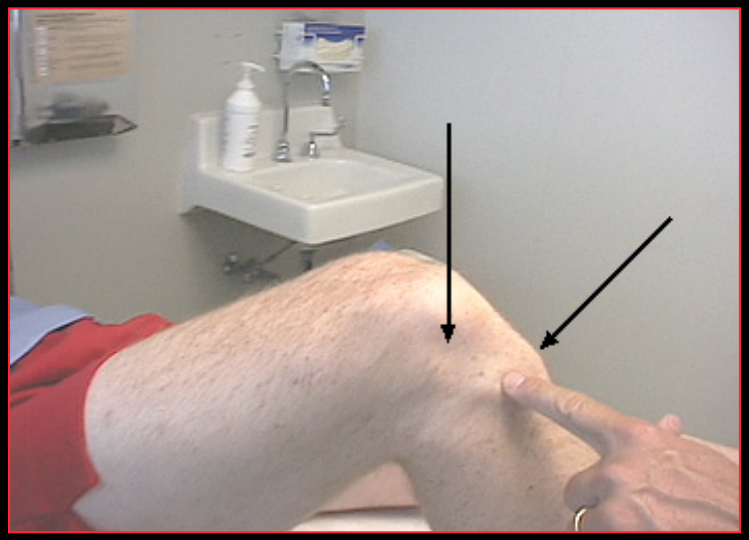
In the tibial drop back test, the examiner compares the prominence of the proximal tibia to the femoral condyles with the knee flexed to 80°. In a PCL deficient knee, the knee be posteriorly subluxed due to gravity.



In the normal knee at 80° the tibial plateau is located approximately 1 cm anterior to the femoral condyles.

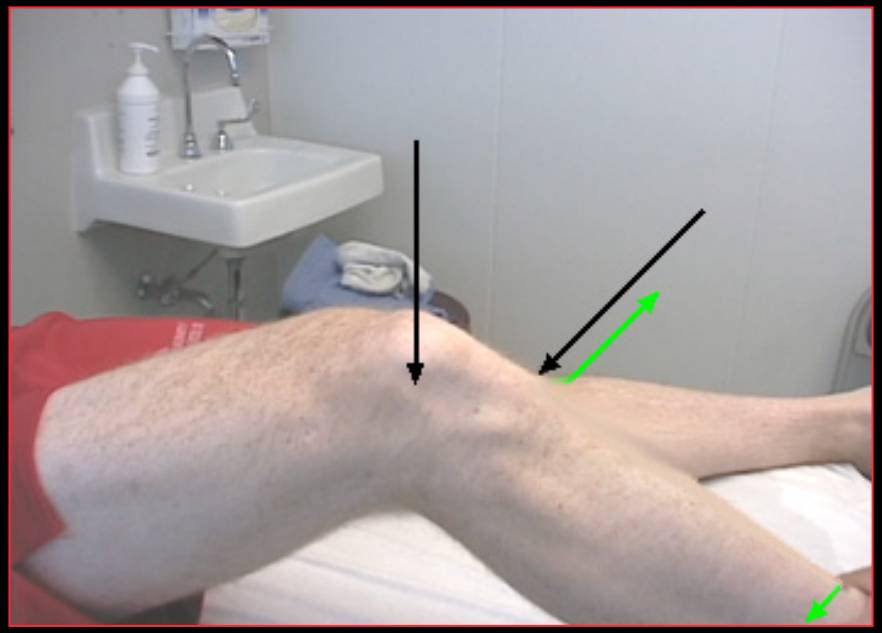
Tibial drop back in a PCL deficient left knee

Quadriceps Active Test



The quadriceps active test is performed with the knee flexed to 80° and in neutral rotation. Its starting point is in effect the tibial drop back test.

From its initial relaxed position at 80°, the patient is asked to fire their quadriceps muscle ("straighten out your leg") while the examiner applies counter pressure against the ankle.



The quadriceps pulls anteriorly through the tibial tubercle to reduce any posterior translation in the knee.

Posterior Drawer

ΠΟΣΟΤΙΚΗ ΜΕΤΡΗΣΗ ΤΗΣ ΠΡΟΣΘΙΑΣ ΠΑΡΕΚΤΟΠΙΣΗΣ ΤΗΣ ΚΝΗΜΗΣ

ΑΡΘΡΟΜΕΤΡΑ

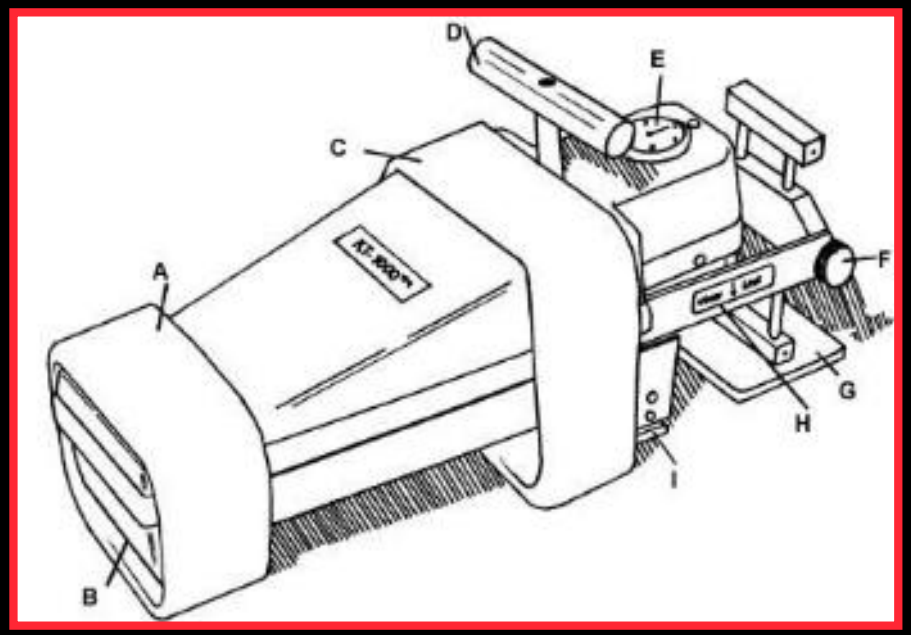
- Medmetrics KT 1000, 2000
- Stryker Knee Laxity Tester
- Acuflex Knee Signature System
- Dyonics Dynamic Cruciate Tester
- Genucom Knee Analysis System
- Leicester Arthrometer
- UCLA Arthrometer
- Telos Arthrometer
- Kneelax 3 (Biodex)

ΠΟΣΟΤΙΚΗ ΜΕΤΡΗΣΗ ΤΗΣ ΠΡΟΣΘΙΑΣ ΠΑΡΕΚΤΟΠΙΣΗΣ ΤΗΣ ΚΝΗΜΗΣ

- Παθητική πρόσθια μετατόπιση της κνήμης
- Ακρίβεια των μετρήσεων
- Διάγνωση ρήξεων ΠΧΣ με ποσοτικά κριτήρια
- Δυνατότητα ποσοτικής παρακολούθησης των συνδεσμοπλαστικών ΠΧΣ
- Δεν απαιτείται

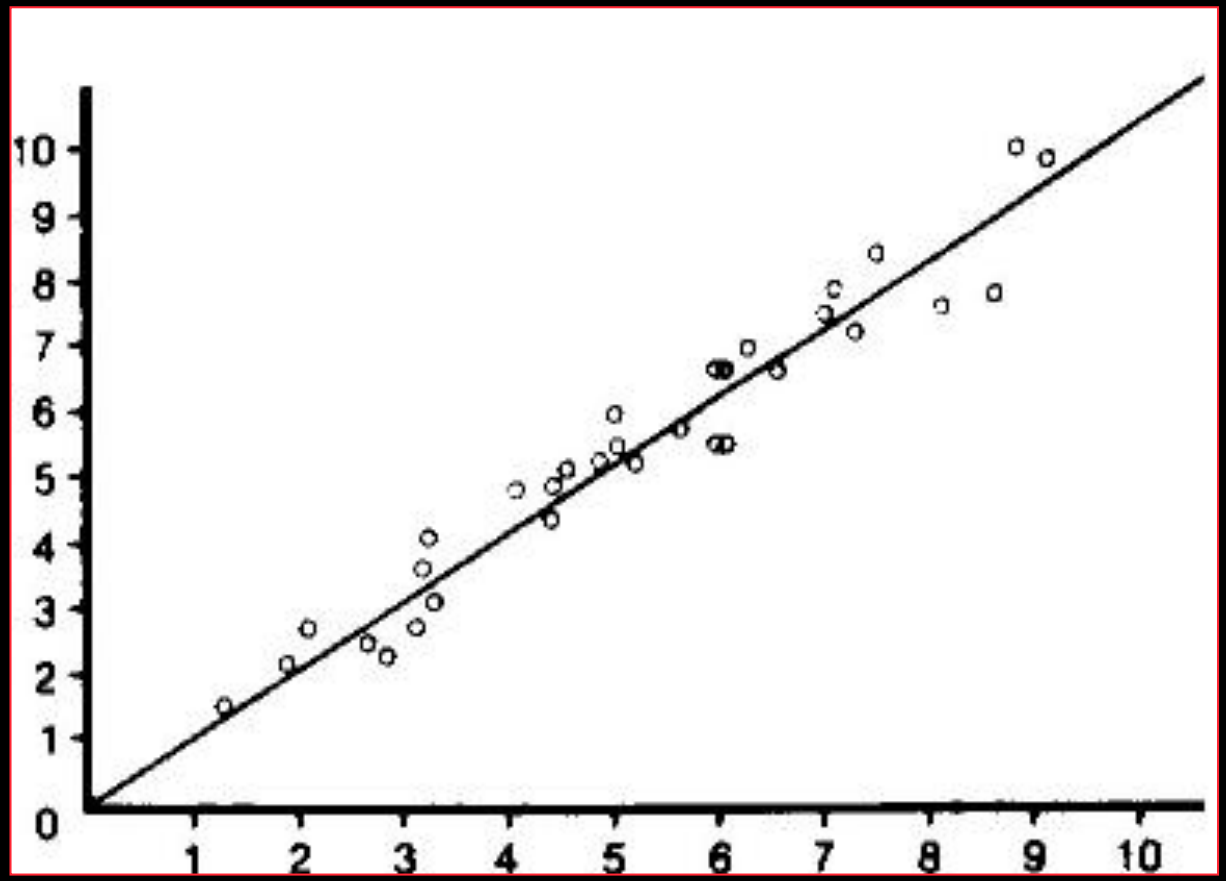
K T - 1000

1982, Dale M. Daniel M.D., San Diego, CA

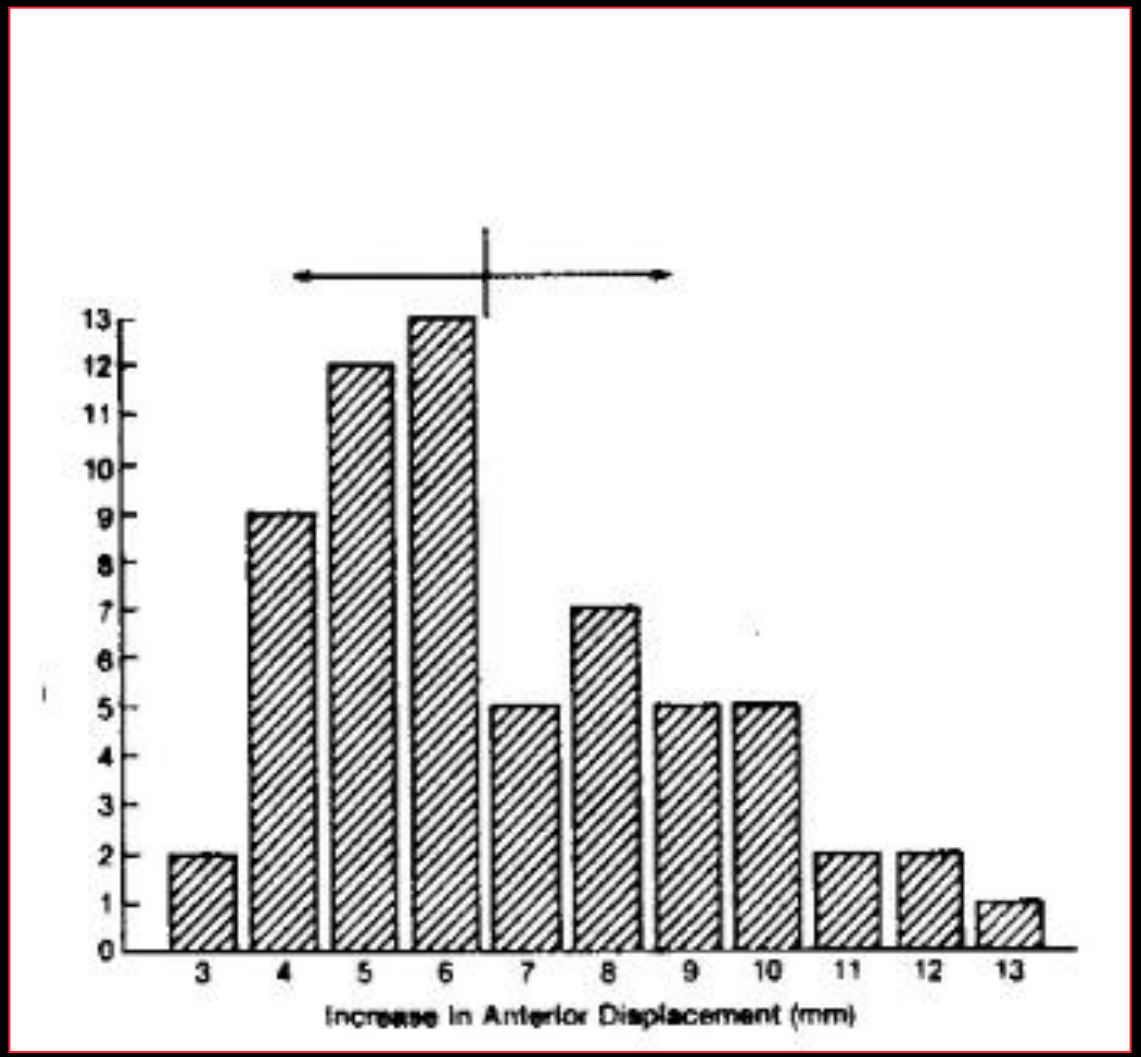


KT2000™ $7450.00 USD

Arthrometer Measurements vs Actual Skeletal Displacements in Cadavers



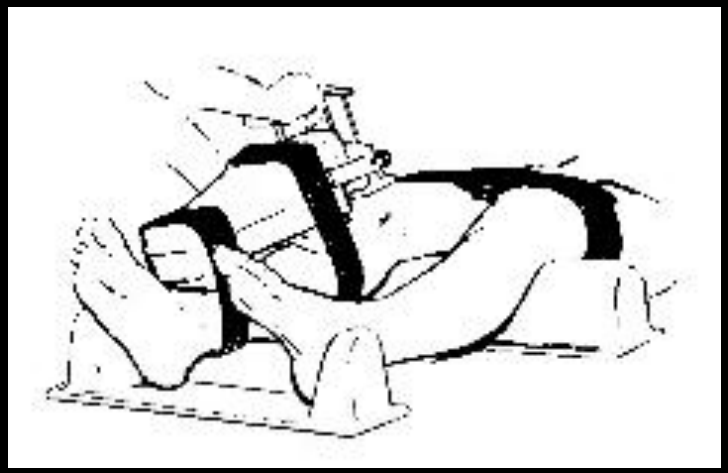
Effect of Anterior Cruciate Ligament Section on Anterior Displacement



- ✓ The precision of A-P displacement measurements are dependent on a standardized method of placing the leg and securely stabilizing the patella in the femoral trochlea.
- ✓ With adequate patellar stabilization, tibial tubercle motion relative to the patella accurately reflects motion of the tibia relative to the femur.
- ✓ It is necessary to flex the knee 20 to 30 degrees in order to engage the patella in the femoral trochlea.
- ✓ In patients with patella alta or lateral tracking patella, the knee may need to be flexed to 40 degrees.

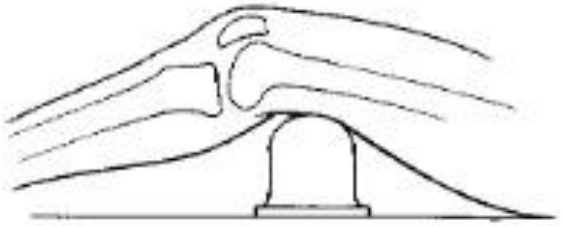
The patella is stabilized in the femoral trochlea by direct pressure which should be oriented to seat the patella.

The patellar stabilization pressure must remain constant.



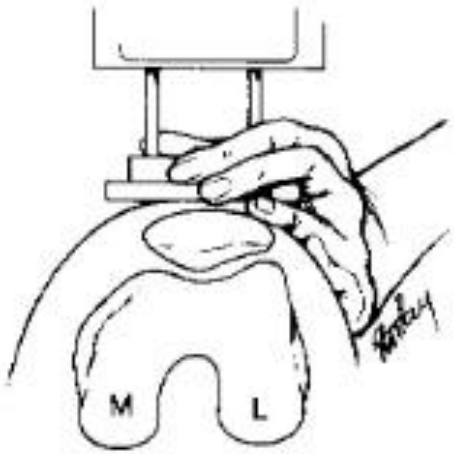
KT1000
Stabilization of Patella

Flex knee to engage patella in femoral trochlea



Support thigh to place patella facing up

Apply pressure to stabilize patella



Important points are:

- ✓ Muscle relaxation.
- ✓ Similar limb orientation.
- ✓ Similar Arthrometer placement on the leg in respect to the instrument marker at the joint line and instrument rotation in relation to the patella.
- ✓ Consistent patella pad pressure technique and establishing the testing reference position.
- ✓ Establishing the testing reference position.
- ✓ Similar speed and vector of force application.

The two greatest sources of measurement errors with the Arthrometer are lack of muscle relaxation and inability to stabilize the patellar sensor pad.

[redacted]

Table I
Normal A-P Displacement Measurements

Range	Low	High	Mean	St. Dev.	95% Cut-Off
Displacement (n = 240)					
20 lb. Posterior	1	6	2.8	0.9	4.5
20 lb. Anterior	5	14.7	7.2	2.0	10
20 lb. Anterior-Posterior	5	18	10.0	2.4	12
Manual Maximum Anterior	4.5	15.	8.6	2.1	12
Quadriceps Active Displacement	2	12.5	5.7	1.8	9
Right Minus Left (n = 120)					
20 lb. Posterior	0	2	0	0.7	1.0*
20 lb. Anterior	-0.2	-3.5	-2.0	1.0	2.0*
20 lb. Anterior-Posterior	-4	4	0.2	0.9	2.5*
Manual Maximum Anterior	-4	3	-0.3	1.1	2.0*
Quadriceps Active Displacement	-3	2	-0.4	1.0	2.0*

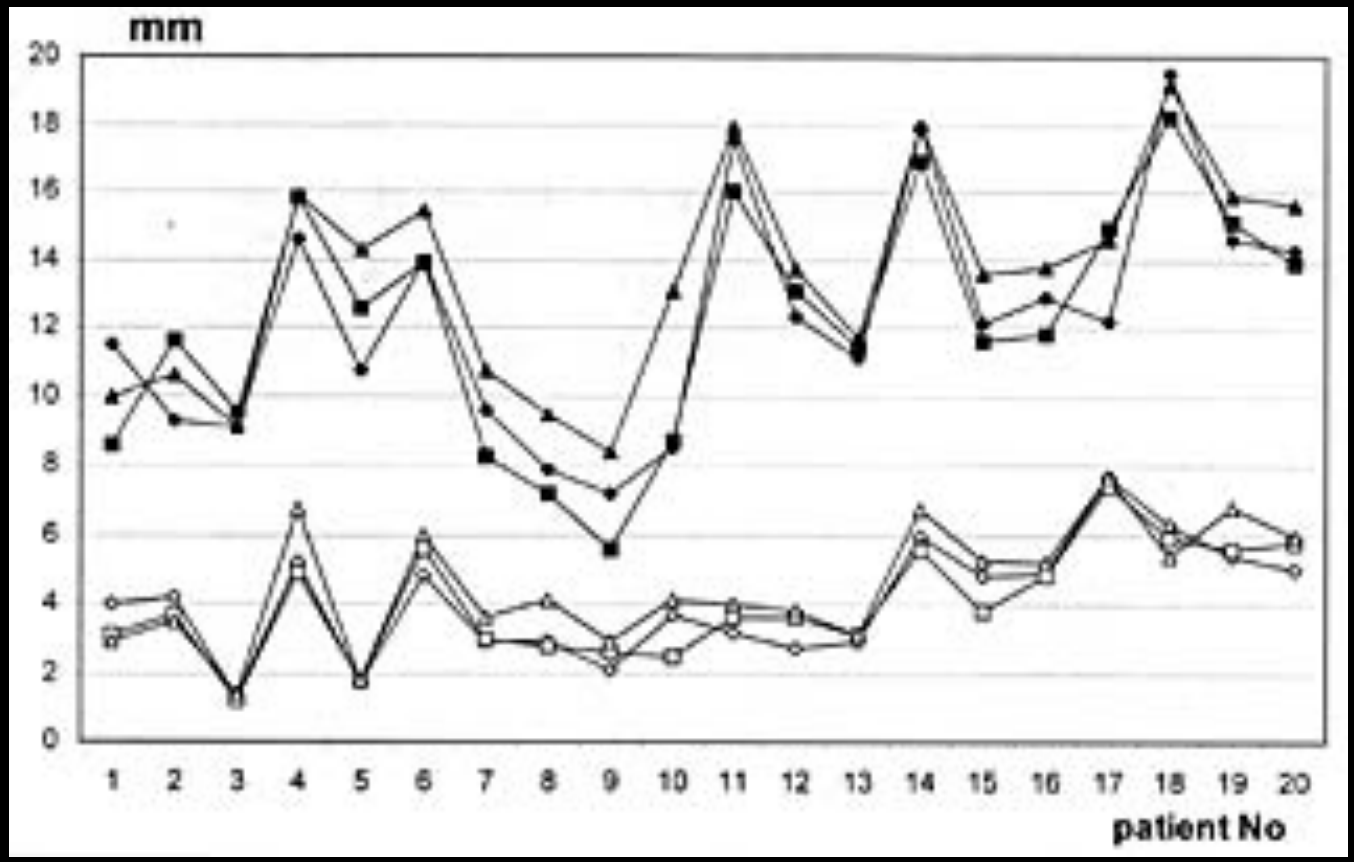
*** Right-left difference**

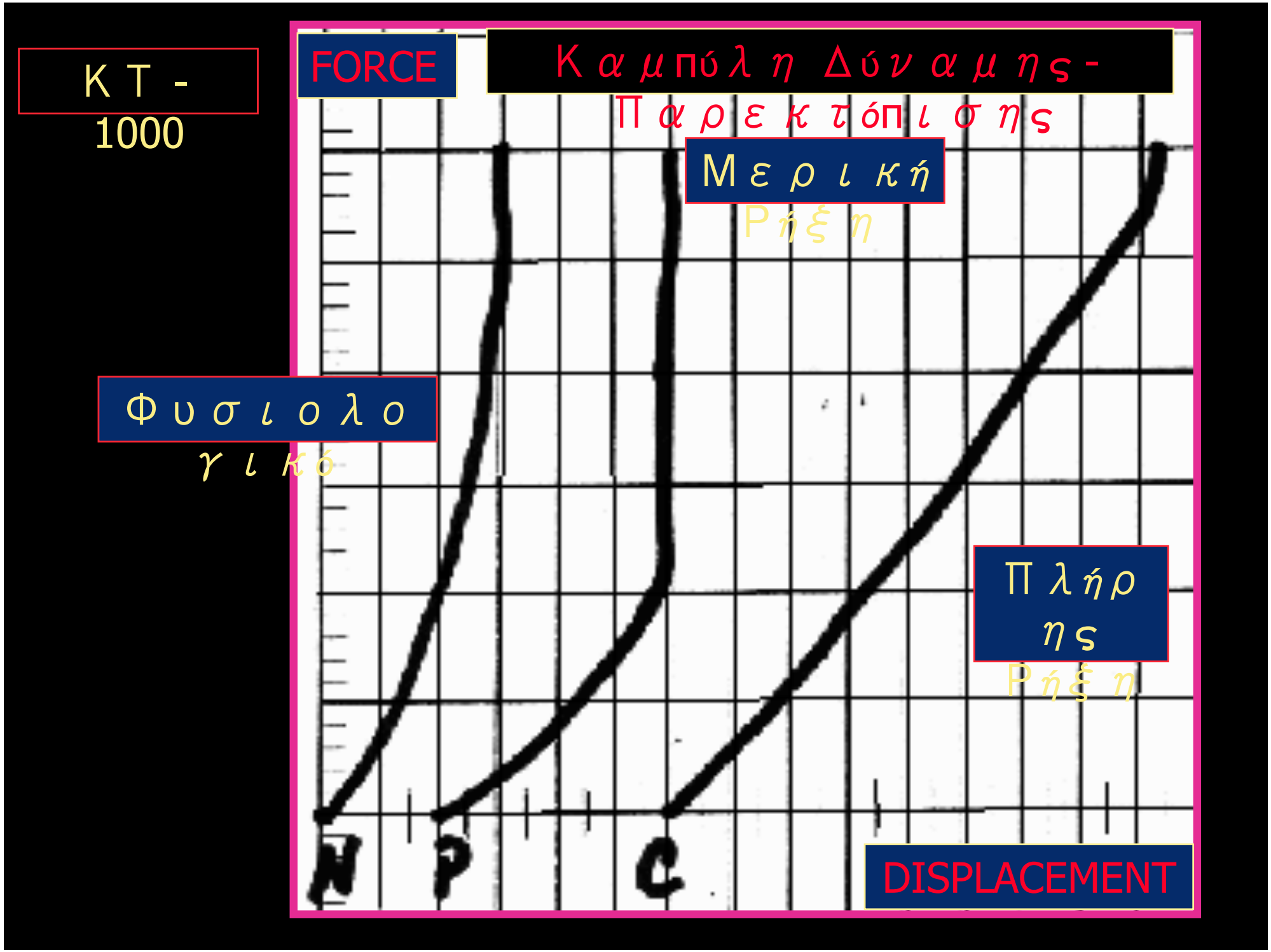
[redacted]

Table II
Unilateral Chronic ACL Disruption Injured Minus Normal
Displacement Difference Knee Flexion Angle 20-35 Degrees

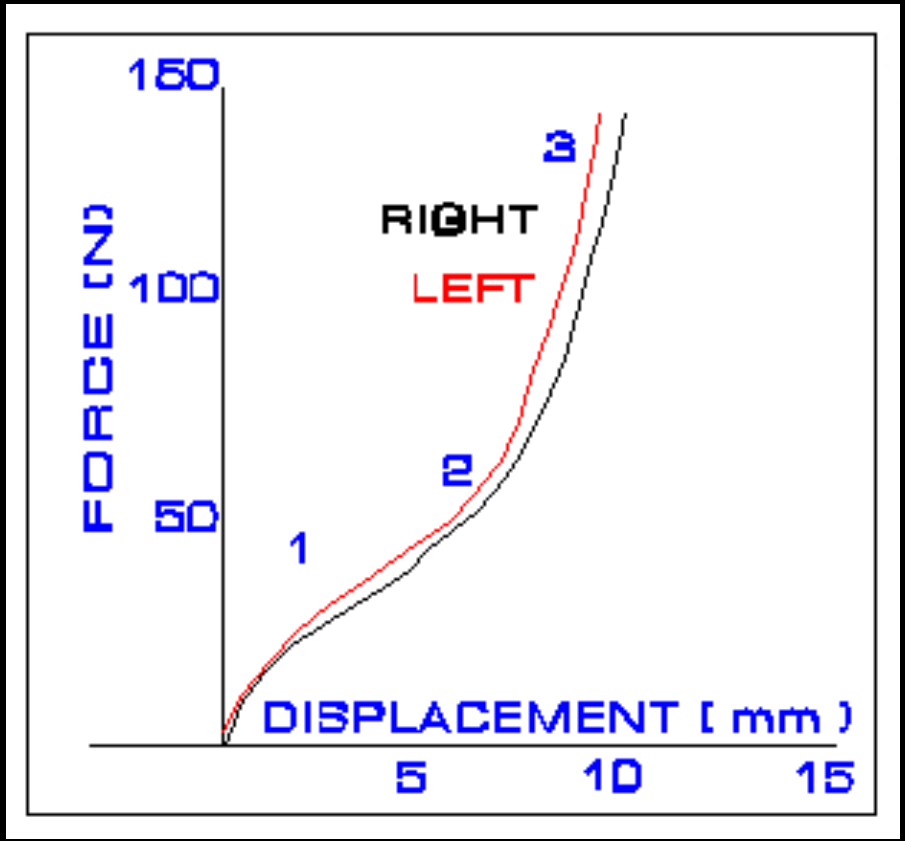
Clinic Examination Author	n.	Mean	³ 3.0
Test: 20 lb.			
Anderson (2)	35	4.3	--
Bach (3)	153	--	79%
KSD (a)	177	5.2	85%
Drez (b)	19	6.3	--
3M LAD (c)	297	6.1	89%
Sherman (40)	19	5.1	95%
Test: Manual Maximum			
Bach	153	--	72%
KSD	177	8.5	99%
3M LAD	297	7.8	96%
Test: Quadriceps Active			
KSD	177	43.3	70%
3M LAD	258	4.4	76%

Examination Under Anesthesia Prior to Reconstruction			
Test: 20 lb.			
KSD	223	5.6	87%
3M LAD	297	639	96%
Test: Manual Maximum			
KSD	223	8.9	97%
3M LAD	297	8.9	99%
Examination Under Anesthesia After Reconstruction			
Test: 20 lb. (I-N)			
KSD	223	-1.4	5%

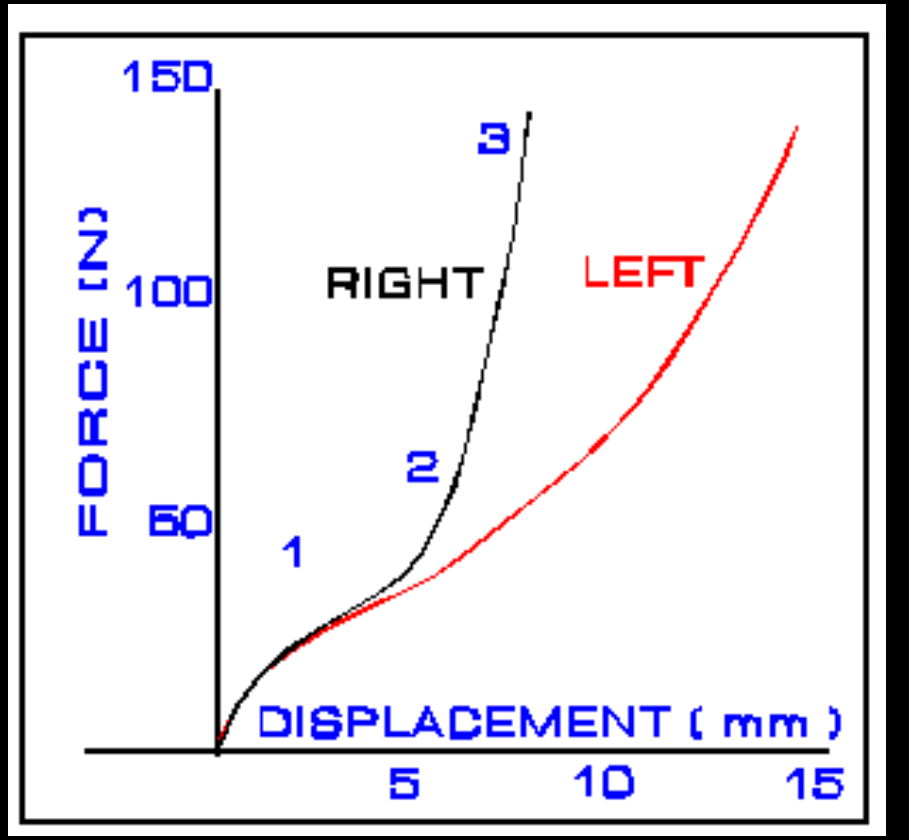

mm
20
18
16
14
12
10
8
6
4
2
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
patient No


Κ Τ - 1000
FORCE
Καμπύλη Δύναμης - Παρεκτόπισης
Μερική Ρήξη
Φυσιολογικό
Πλήρης Ρήξη
N
P
C
DISPLACEMENT

φυσιολογικό



ρήξη ΠΧΣ



Η Συσκευή

Rolimeter ™

Βιβλιογραφία

Rolimeter ™

- ✓ KT-1000 and Rolimeter showed significantly better results than the manual Lachman.
- ✓ The Rolimeter tended to measure -1 mm less ap displacement than the KT-1000 at manual maximum stress.
- ✓ Rolimeter measurements were more consistent than the KT-1000 measurements.
- ✓ Specificity and sensitivity were equivalent between the two arthrometers

Evaluation of anterior knee joint instability with the Rolimeter. A test in comparison with manual assessment and measuring with the KT-1000 arthrometer.

Balasch H, Schiller M, Friebel H, Hoffmann F.
Knee Surg Sports Traumatol Arthrosc 1999;7(4):204-208

Βιβλιογραφία

Rolimeter ™

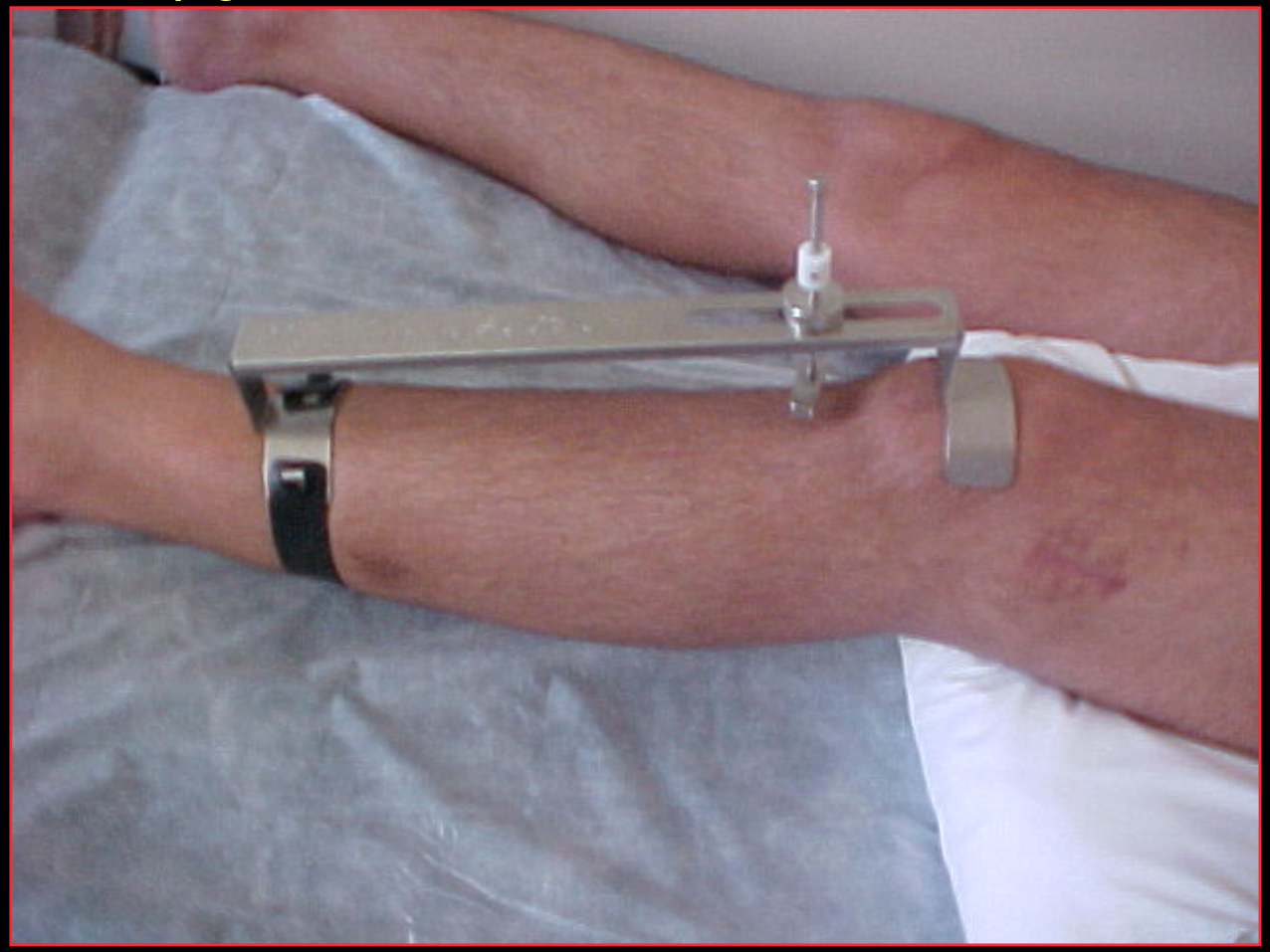
- In ACL-deficient knees the absolute translation and the side-to-side difference did not differ significantly between the devices.

- In normal knees the Rolimeter measured slightly smaller translations than the KT-1000, but with a high degree of correlation between devices

The rolimeter: a new arthrometer compared with the KT-1000.

Ganko A, Engebretsen L, Ozer H. Knee Surg Sports Traumatol Arthrosc 2000;8(1):36-39

Μέθοδος Εξέτασης



maximum manual force (150-200 N)

functional knee criteria, although partially subjective, are more useful indicators of outcome than intrareconstruction and postreconstruction arthrometric measures

The predictive value of intraoperative KT-1000 arthrometer measurements in single incision anterior cruciate ligament reconstruction.

Giannotti BF et al. Arthroscopy 1996;12(6):660-666

- Significant ($P < 0.05$) increases in translation were found only after sectioning both the posterolateral bundle and half of the anteromedial bundle and after complete sectioning of the ACL

- A soft end point to the Lachman examination was noted only after cutting at least 75% of the ligament, but was not always present

Increased tibial translation after partial sectioning of the anterior cruciate ligament.
Hole RL et al Am J Sports Med 1996 ;24(4):556-560

We recommend that a < 3 mm side-to-side difference be used to indicate stable knees

Relative and absolute reliability of the KT-2000 arthrometer for uninjured knees. Testing at 67, 89, 134, and 178 N and manual maximum forces.

Myrer JW et al.Am J Sports Med 1996;24(1):104-108

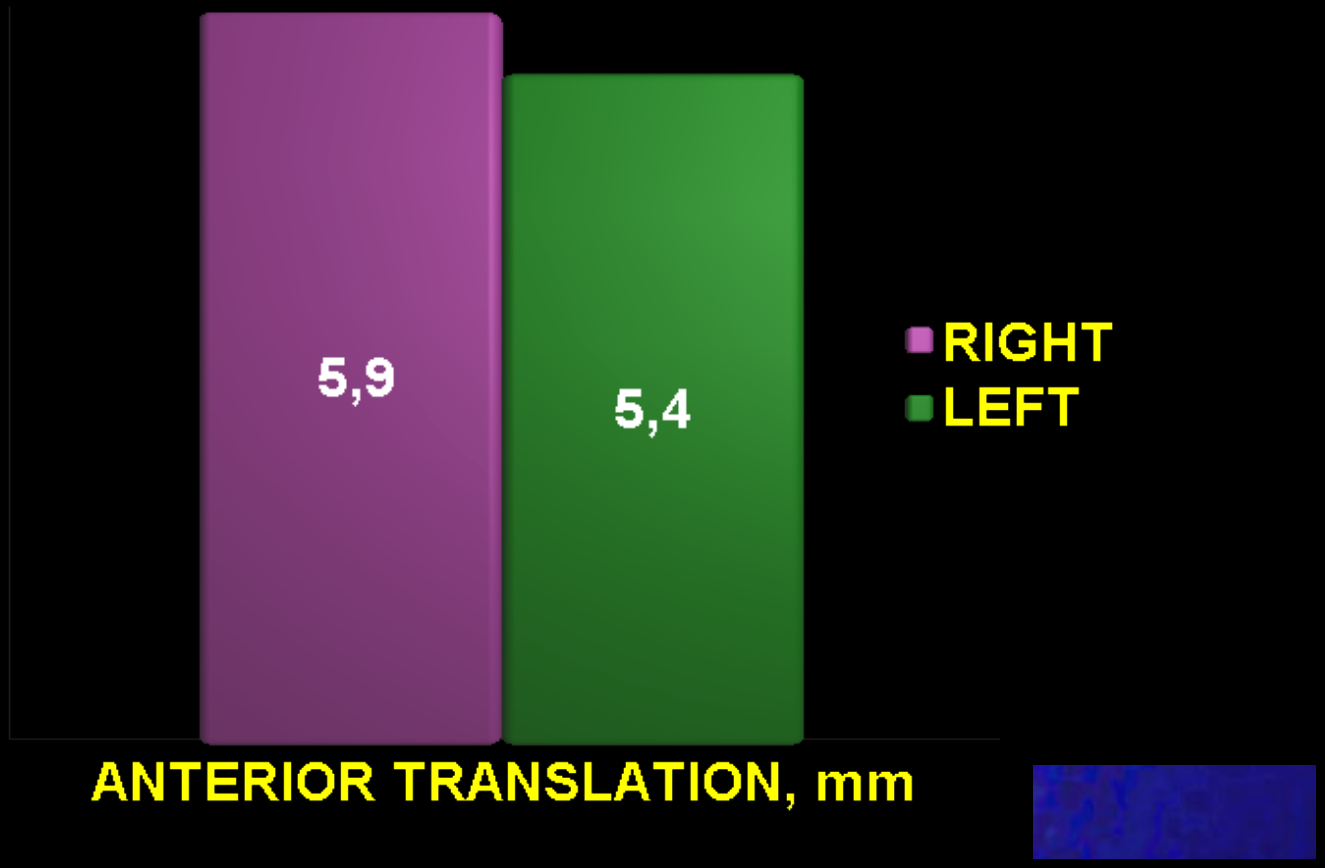
Measurements of anterior laxity in anterior cruciate ligament-deficient patients were not correlated with measures of functional outcome used in this study

The relationship between passive joint laxity and functional outcome after anterior cruciate ligament injury.

Snyder-Mackler L et al.Am J Sports Med 1997 Mar-Apr;25(2):191-5

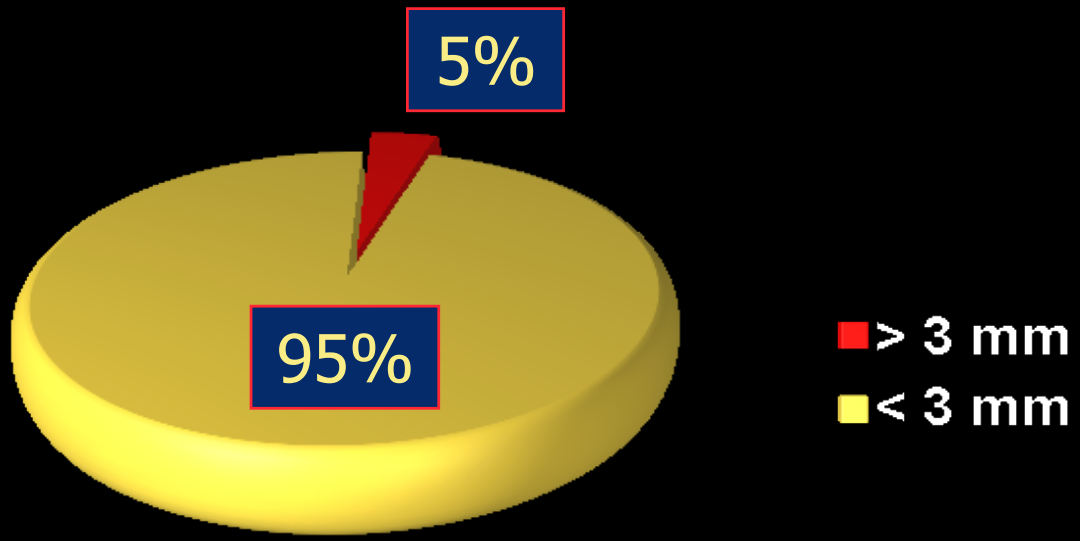
Αποτελέσματα

Ομάδα Α – Φυσιολογικά Άτομα



Αποτελέσματα

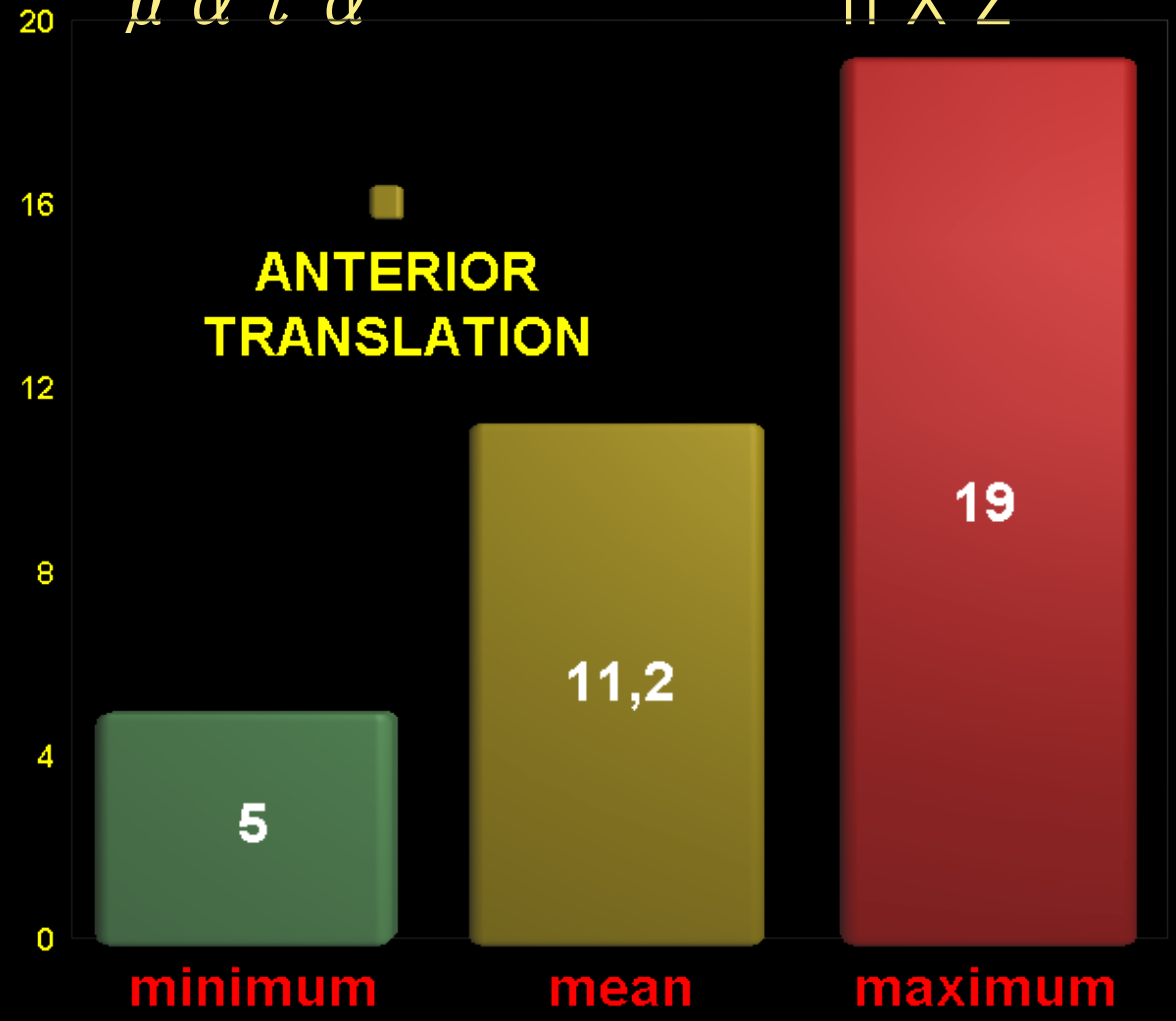
Ομάδα Α – Φυσιολογικά Άτομα



Η διαφορά δεξιού – αριστερού γόνατος στον φυσιολογικό πληθυσμό ήταν μικρότερη των 3 mm στο 95% (36/38)

Αποτελέσματα

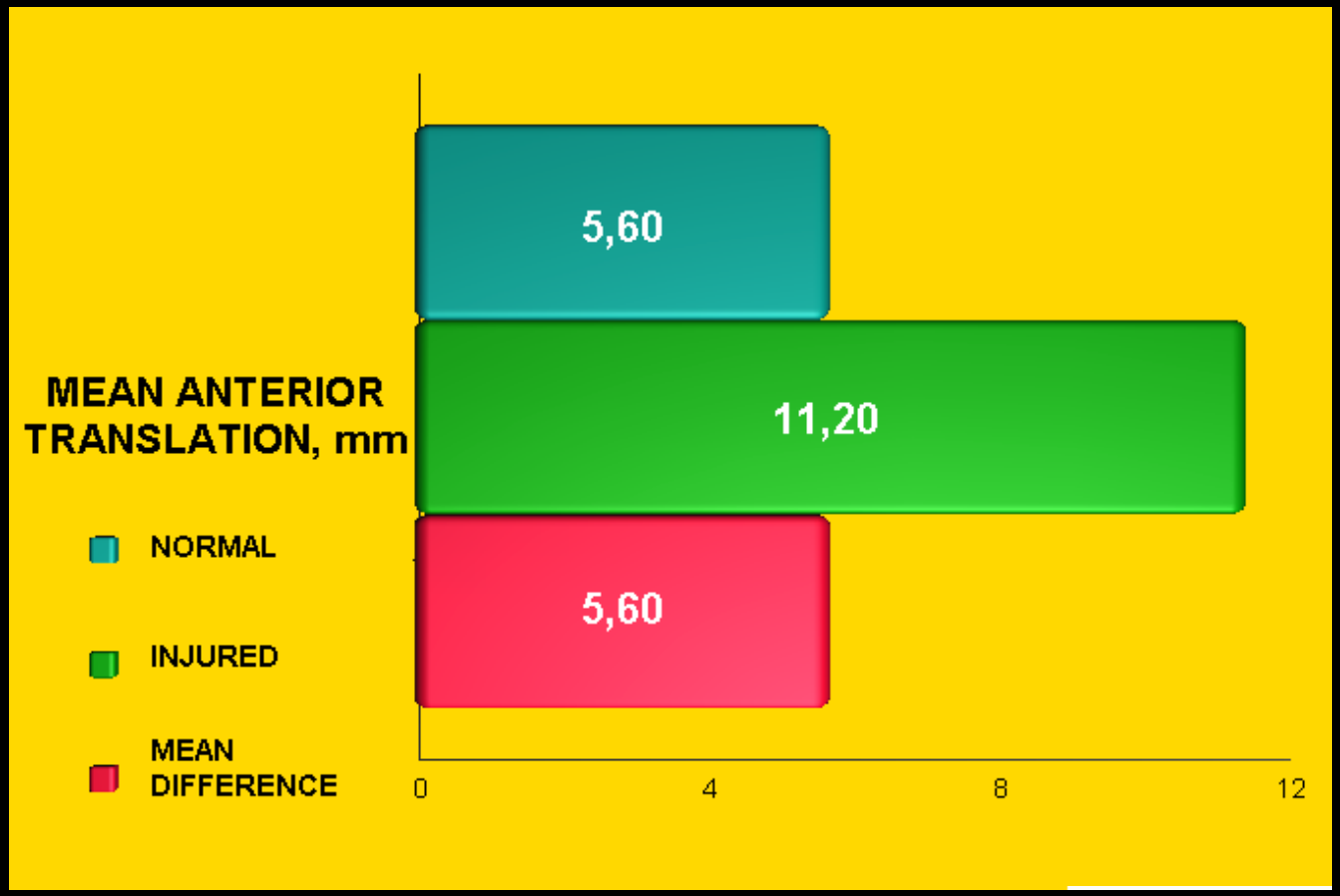
Ομάδα Β – Ρήξη ΠΧΣ



Σε ρήξη ΠΧΣ η απόλυτη μετατόπιση ήταν 11,2 mm

Αποτελέσματα

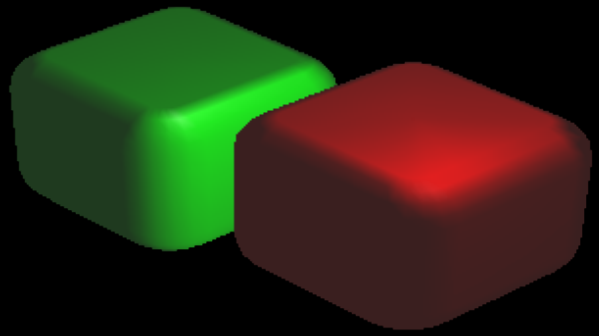
Ομάδα Β – Ρήξη ΠΧΣ



Η μέση διαφορά μεταξύ των δύο γονάτων ήταν 5.6 mm

Αποτελέσματα

Ομάδα Β – Ρήξη ΠΧΣ



> 3 mm

< 3 mm

Η μέγιστη διαφορά τραυματισμένου-φυσιολογικού γόνατος ήταν μεγαλύτερη ή ίση των 3 mm στο 95,45%

Αποτελέσματα

Η μέση διαφορά μεταξύ των δύο γονάτων ήταν:

- ✓ Σε ρήξη ΠΧΣ > 5 mm ($p < 0.001$)
- ✓ Σε φυσιολογικά άτομα < 3 mm

ΣΥΜΠΕΡΑΣΜΑ

- Η χρήση της συσκευής Rolimeter καθιστά δυνατή τη διάκριση μεταξύ του φυσιολογικού γόνατος και αυτού με ρήξη ΠΧΣ
- Η τεχνική είναι εύκολη, αναπαραγώγιμη
- Απαιτείται εμπειρία του χειριστή στην κλινική εξέταση του γόνατος

ΕΥΧΑΡΙΣΤΩ