

### Isokinetic Certification 101 Episode 7: Isometric testing

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THROUGH  
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#### Introduction to Isokinetic Training and Testing

Course Instructors:

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Daniel Bodkin PT, DPT, ATC



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- CSMi
- Daniel Bodkin PT, DPT, ATC
- Email questions to Rob:  
Rob.potash@csmisolutions.com



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- Register your clinic for free at  
Cybextest.org
- Catch up or review previous  
episodes at isokinetics101.org
- csmisolutions.com



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### Additional Videos on Youtube

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#### - Episode 5 Isokinetic Strength

- Shoulder, Elbow, Wrist/Forearm, Ankle
- <https://youtu.be/r04htkcoobc>

#### - Episode 6 Isotonic Control

- How to set up isotonic mode in Dashboard
- [https://youtu.be/\\_wzq1Vt-q4Y](https://youtu.be/_wzq1Vt-q4Y)



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### Shout Outs

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Erik Meira PT, DPT, SCS, CSCS  
 J.W. Matheson PT, DPT, MS, SCS, OCS, CSCS

CSMI Intro music provided by bensound.com

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### Discussion Topics

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#### Past:

- History & Science
- Course Preview
- Mobility
- Stability
- Strength
- Control

#### Present:

- Isometric Testing

#### Future:

- Aug: Isokinetic Testing
- Sept-Dec: Case Studies/POC's, guests, review & wrap up

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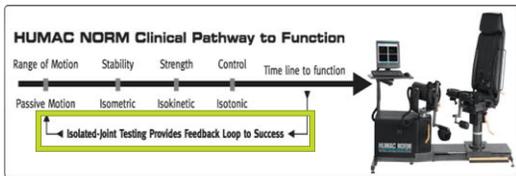
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### THE FIVE BASIC PHASES OF REHABILITATION

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**WHERE SHOULD AN ACL REPAIR GET TESTED?**

BEFORE THEY PUSH THEIR MAX ON THE FIELD, TEST THEM IN YOUR TRAINING ROOM.

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ISOKINETICS provides the knowledge you need to make informed decisions for your players. An athlete's maximum effort is measured at every point of the range-of-motion using fixed speed and variable resistance, providing data you can rely on. See HUMAC NORM in action at NATA HOUSTON (BOOTH 4067) and receive our elite athlete isokinetic results poster **FOR FREE**.

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### Patient Preparation?

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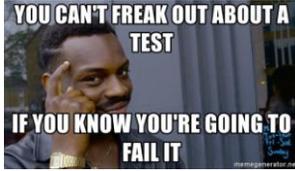
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**Patient Preparation?**




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**Cristiani R, Mikkelsen C, Forssblad M, Engstrom B, Stalman A. Only one patient out of five achieves symmetrical knee function 6 months after primary anterior cruciate ligament reconstruction. Knee Surg Sports Traumatol Arthrosc. 2019 Feb 18.**



- Patients who underwent primary ACLR from 2000 to 2015 and were assessed with the isokinetic quadriceps and hamstring muscles strength tests and single-leg-hop test at the 6-month follow-up.
- Limb symmetry index (LSI) of  $\geq 90\%$  in all three tests were considered to have achieved symmetrical knee function.
- A total of 4093 patients (54.3% males) with a mean age of  $28.3 \pm 10.7$  years were included.
- The proportion of patients that achieved a LSI of  $\geq 90\%$  was:
  - Isokinetic quad strength 35.7%
  - Isokinetic hamstring strength 47.3%
  - Single leg hop 67.9%
  - All three measures 19.6%
- Age  $\geq 30$  years, MM resection and MM repair reduced the chance, whereas the use of HT over BPTB increased the chance of achieving symmetrical knee function 6 months after primary ACLR.

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**Barfod K, Feller J, Hartwig T, Devitt B, Webster K. Knee extensor strength and hop test performance following anterior cruciate ligament reconstruction. Knee. 2019 Jan;26(1):149-154.**



- Sixty-nine patients aged 14 to 45 undergoing primary ACL reconstruction were tested with isokinetic concentric quad testing and single limb hop for distance at 6 and 12 months postoperatively.
- At 6 months:
  - 27.5% had recovered satisfactory quad strength (LSI  $>85\%$ ) and 66.7% had satisfactory hopping symmetry
- At 12 months:
  - 46.4% had recovered satisfactory quad strength and 89.9% had satisfactory hopping symmetry
- Less than 1 in 3 patients at 6 months and 1 in 2 at 12 months had recovered satisfactory quad strength.
- Recovery of quad strength was associated with hopping distance but recovery of hopping distance was not associated with quad strength. Hop symmetry was achieved considerably faster than quad symmetry.
- Single leg hop test cannot be used as a surrogate measure for quad strength.

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**Barfod K, Feller J, Hartwig T, Devitt B, Webster K. Knee extensor strength and hop test performance following anterior cruciate ligament reconstruction. *Knee*. 2019 Jan;26(1):149-154.**

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**Schmitt L, Paterno M, Hewett T. The impact of quadriceps femoris strength asymmetry on functional performance at return to sport following anterior cruciate ligament reconstruction. *J Orthop Sports Phys Ther*. 2012 Sep;42(9):750-9.**

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- 45 athletes (17.3 years/ACLR group) and 35 uninjured (17.0 years control group)
  - Quad MV/C was assessed, and the quadriceps index (QI) was calculated.
- The ACLR group was further subdivided into 2 groups:
  - QI: high quadriceps (QI of 90% or greater) and low quadriceps (QI of less than 85%).
- The IKDC and hop tests were used to assess subjective and functional performance.
- Those in the ACLR group were weaker, reported worse function, and performed worse on hop tests compared to those in the control group
- The low-quadriceps group performed worse on the hop tests compared to the high-quadriceps group and the control group
- Hop test performance did not differ between the high-quadriceps and control groups
- Quad strength predicted performance on the hop tests beyond graft type, presence of meniscus injury, knee pain, and knee symptoms.

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**Schmitt L, Paterno M, Ford K, Myer G, Hewett T. Strength asymmetry and landing mechanics at return to sport after anterior cruciate ligament reconstruction. *Med Sci Sports Exerc*. 2015 Jul;47(7):1426-34.**

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- 77 individuals (17.4 yr; ACLR group) and 47 (17.0 yr; CTRL group)
- ACLR group was divided as with previous study but this time knee kinematic and kinetic variables were collected during a drop vertical jump maneuver.
- The LQ group demonstrated worse asymmetry in all kinetic and ground reaction force variables compared to the HQ and CTRL groups, including:
  - reduced involved limb peak knee external flexion moments
  - reduced involved limb and increased uninvolved limb peak vertical ground reaction forces
  - higher uninvolved limb peak loading rates
- There were no differences in the landing patterns between the HQ and CTRL groups on any variable.
- In the ACLR group, QI strength estimated limb symmetry during landing after controlling for graft type, meniscus injury, knee pain, and symptoms.

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**Ithurburn M, Paterno M, Ford K, Hewett T, Schmitt L. Young athletes with quadriceps femoris strength asymmetry at return to sport after anterior cruciate ligament reconstruction demonstrate asymmetric single-leg drop-landing mechanics. Am J Sports Med. 2015 Nov;43(11):2727-37**

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- 103 participants (age, 17.4 years) in the ACLR group and 47 control participants (age, 17.0 years).
- Same grouping and subdivision of ACLR groups
- Biomechanical data were collected by use of 3-dimensional motion analysis during a single-leg drop-landing task. The LSI was calculated for kinematic and kinetic sagittal-plane variables during landing.
- All of those in the ACLR group demonstrated asymmetry compared with controls.
- In the ACL reconstruction group, quadriceps strength symmetry predicted symmetry in:
  - knee flexion excursion, peak trunk flexion, peak knee extension moment (all  $P < .001$ )
- LQ group demonstrated greater movement asymmetry compared with HQ group including:
  - increased trunk flexion, decreased knee flexion excursion, decreased knee extension moments
- Quad symmetry predicted symmetry in peak trunk flexion angle ( $P < .001$ ) after controlling for graft type, knee-related pain, function with activities of daily living, and sport function.

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## Follow-up Research

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- Ithurburn M, Altenburger A, Thomas S, Hewett T, Paterno M, Schmitt L. Young athletes after ACL reconstruction with quadriceps strength asymmetry at the time of return-to-sport demonstrate decreased knee function 1 year later. Knee Surg Sports Traumatol Arthrosc. 2018 Feb;26(2):426-433.
- Ithurburn M, Paterno M, Ford K, Hewett T, Schmitt L. Young athletes after anterior cruciate ligament reconstruction with single-leg landing asymmetries at the time of return to sport demonstrate decreased knee function 2 years later. Am J Sports Med. 2017 Sep;45(11):2604-2613.

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**Wellsandt E, Failla MJ, Snyder-Mackler L. Limb symmetry indexes can overestimate knee function after anterior cruciate ligament injury. J Orthop Sports Phys Ther. 2017 May;47(5):334-338**

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- 70 ACL injured athletes completed quadriceps strength and 4 single-leg hop tests before surgery and 6 months after. LSIs for each test compared involved-limb measures at 6 months to uninvolved-limb measures at 6 months.
- Estimated preinjury capacity (EPIC) levels for each test compared involved-limb measures at 6 months to uninvolved-limb measures before ACLR. Second ACL injuries were tracked for a minimum follow-up of 2 years.
- Results:
  - 28.6% patients met 90% EPIC levels for quadriceps strength and all hop tests.
  - 57.1% achieved 90% LSIs for quadriceps strength and all hop tests.
  - 34.3% patients who achieved 90% LSIs for all measures 6 months after did not achieve 90% EPIC levels for all measures.
  - EPIC levels were more sensitive than LSIs in predicting second ACL injuries (LSIs: 0.273 and EPIC: 0.818).
- LSIs frequently overestimate knee function after ACLR and may be related to second ACL injury risk.

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Body weight?

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**Angelozzi M, Madama M, Corsica C, Calvisi V, Properzi G, McCaw ST, Cacchio A. Rate of force development as an adjunctive outcome measure for return-to-sport decisions after anterior cruciate ligament reconstruction. J Orthop Sports Phys Ther. 2012 Sep;42(9):772-80.**

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- 45 male professional soccer players who underwent an ACLR and assessed with the IKDC, Tegner score, and KT1000 post-injury/pre-op and at 6 and 12 months after ACL reconstruction.
- MVIC, RFD at 30,50, and 90% MVIC testing was performed pre-injury and at 6 and 12 months post-ACL reconstruction.
- At 6 months:
  - Average MVIC 97% of the pre-injury value.
  - RFD(30) 80%
  - RFD(50) 77%
  - RFD(90) 63%.
- The mean RFD values attained or exceeded 90% of the preinjury mean values only at the 12-month post-op.
- Despite the near recovery of MVIC strength to preinjury levels, there were still significant deficits in RFD at 6 months.
- RFD criteria may be a useful adjunct outcome measure for the decision to return athletes to sports.

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**Pua V, Mentiply B, Clark R, Ho J. Associations among quadriceps strength and rate of torque development 6 weeks post anterior cruciate ligament reconstruction and future hop and vertical jump performance: A prospective cohort study. J Orthop Sports Phys Ther. 2017 Nov;47(11):845-852.**

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- 70 patients with unilateral ACL reconstruction
  - 6 weeks post-op: isometric quadriceps strength and RTD
  - 6 months post-op: single-leg hop for distance, single-leg vertical jump test on a force plate that measured maximum jump height, vGRF, and average loading rate during landing.
- Both strength and RTD at 6 weeks post-op were associated with all hopping and jumping at 6 months.
  - Single-leg hop distance was associated more closely with quadriceps strength
  - Vertical jump height and vGRF measures were associated more closely with quadriceps RTD.
  - Both quadriceps measures were associated with loading rate.
- Quadriceps strength and RTD are complementary but distinct predictors of future hopping and jumping performance.

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**Harpuz G, Kilinc N, Ozer H, Baltaci G, Mattacola C. Quadriceps and hamstring strength recovery during early neuromuscular rehabilitation after ACL hamstring-tendon autograft reconstruction. J Sport Rehabil. 2015 Nov;24(4):398-404.**

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- 24 patients (age 28.1 ± 8.1) who underwent unilateral single-bundle anatomic ACLR with 4-strand semitendinosus and gracilis tendon graft.
- The isometric strength of quadriceps and hamstring muscles was measured at 4, 8, and 12 wk after surgery.
- Quad and hamstring strength significantly increased over time for both the involved limb and uninvolved limb.
  - 4 wk (QI 57.9, HI 54.4)
  - 8 wk (QI 78.8, HI 69.9)
  - 12 wk (QI 82, HI 75.7) (P < .001)
- The results of this study serve as a reference for clinicians while directing a rehabilitation protocol for HTG ACLR patients to better appreciate expected strength changes of the muscles in the early phase of recovery.

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### ACL Testing Timeline

- Week 8: Isometric Test
- Week 12: Repeat Isometric Test
- Week 16: Standard Isokinetic Test
  - 2 speed (60 and 300deg/sec) concentric quad and hamstring
- Weeks 20 and 24: Interrupted stroke isokinetic test
  - 60deg/sec concentric and eccentric quad and hamstring

\*\*\*\*\*Repeat testing every 4 weeks until RTP has been met. Repeat testing in off-season and prior to the start of every season to assess readiness.

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### Who Do We Test?

- This is not just for our ACL patients
- Any general orthopedic
  - Post-op (Yes even TKA's and RTC)
  - Fall prevention / Balance dysfunction
  - Neurologic patients

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### Test Procedure

- Always perform a warm-up
- During the warm up, input the patient's information into the computer and explain to them the testing procedure.
- Test the uninvolved limb first
- Proper alignment is important (TAKE YOUR TIME)
- After the test if finished, have your patient perform a cool down while you interpret the data.
- Go over the test with the patient and take the time to explain the findings to them.

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### Isometric Test

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### Data Interpretation

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### Questions/Answers

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“Always pass on what you have learned”

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1. Cristiani R, Mikkelsen C, Forsblad M, Engstrom B, Stalman A. Only one patient out of five achieves symmetrical knee function 6 months after primary anterior cruciate ligament reconstruction. *Knee Surg Sports Traumatol Arthrosc.* 2019 Feb 18.
2. Barfod K, Feller J, Hartwig T, Devitt B, Webster K. Knee extensor strength and hop test performance following anterior cruciate ligament reconstruction. *Knee.* 2019 Jan;26(1):149-154.
3. Schmitt L, Paterno M, Hewett T. The impact of quadriceps femoris strength asymmetry on functional performance at return to sport following anterior cruciate ligament reconstruction. *J Orthop Sports Phys Ther.* 2012 Sep;42(9):750-9.
4. Schmitt L, Paterno M, Ford K, Myer G, Hewett T. Strength Asymmetry and Landing Mechanics at Return to Sport after Anterior Cruciate Ligament Reconstruction. *Med Sci Sports Exerc.* 2015 Jul;47(7):1426-34.
5. Ithurburn M, Paterno M, Ford K, Hewett T, Schmitt L. Young Athletes With Quadriceps Femoris Strength Asymmetry at Return to Sport After Anterior Cruciate Ligament Reconstruction Demonstrate Asymmetric Single-Leg Drop-Landing Mechanics. *Am J Sports Med.* 2015 Nov;43(11):2727-37.
6. Angelozzi M, Madama M, Conica G, Calvisio V, Properi G, McCaw ST, Cacchio A. Rate of force development as an adjunctive outcome measure for return-to-sport decisions after anterior cruciate ligament reconstruction. *J Orthop Sports Phys Ther.* 2012 Sep;42(9):772-80.

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### References

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1. Pua Y, Mentiply B, Clark R, Ho J. Associations among quadriceps strength and rate of torque development 6 weeks post anterior cruciate ligament reconstruction and future hop and vertical jump performance: A prospective cohort study. *J Orthop Sports Phys Ther.* 2017 Nov;47(11):845-852.
2. Wellstrand E, Failla M, Snyder-Mackler L. Limb Symmetry Indexes Can Overestimate Knee Function After Anterior Cruciate Ligament Injury. *J Orthop Sports Phys Ther.* 2017 May;47(5):334-338.
3. Harput G, Kilinc H, Ozer H, Baltaci G, Mattacola C. Quadriceps and hamstring strength recovery during early neuromuscular rehabilitation after ACL hamstring-tendon autograft reconstruction. *J Sport Rehabil.* 2015 Nov;24(4):398-404.
4. Sinacore J, Evans A, Lynch B, Joretz R, Imgang J, Lynch A. Diagnostic Accuracy of Handheld Dynamometry and 1- Repetition-Maximum Tests for Identifying Meaningful Quadriceps Strength Asymmetries. *J Orthop Sports Phys Ther.* 2017 Feb;47(2):97-107.

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## Other References



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