

## Application of VMG in Sports Medicine: Assessing Quadriceps-Hamstring Activity Following ACL Reconstruction

Following ACL injury, athletes wishing to return to their sport are generally advised to undergo ACL reconstruction. Both ACL injury and reconstruction commonly result in quadriceps inhibition and atrophy requiring extended rehabilitation to reverse<sup>1</sup>. An accurate assessment of muscle is critical prior to an athlete returning to normal activity, yet traditional assessment techniques such as isokinetic dynamometry are not well accepted in the medical community as the open-chain, single joint assessments which are possible with dynamometry are poor substitutes for closed-chain, dynamic loading patterns associated with human movement<sup>2</sup>.

Vibromyography (VMG) has distinct benefits over dynamometry in that VMG recordings reproducibly reflect absolute muscle effort up to 100% of maximum voluntary contraction. Correspondingly, VMG can be used to simultaneously evaluate individual muscles (e.g. antagonistic muscle pairs) either over time or to identify left/right differences. Here, we address how VMG can be used to assess quadriceps rehabilitation progress in a young adult male following ACL reconstruction.

### Experimental Protocol

**Subjects:** 21 y.o. adult male collegiate soccer player with torn ACL in right knee, reconstructed 6 months prior.

**Muscles assessed:** *Vastus lateralis* and *biceps femoris*

**Testing protocol:** With left leg instrumented with BIOPAC TSD250 transducers, subject performed 10 deep squats (knees not extending past toes) with three second pauses between each squat. Instrumentation was moved to right leg and protocol was repeated.

### Analysis:

Sixty second recordings were obtained with BIOPAC MP-150 data acquisition unit.

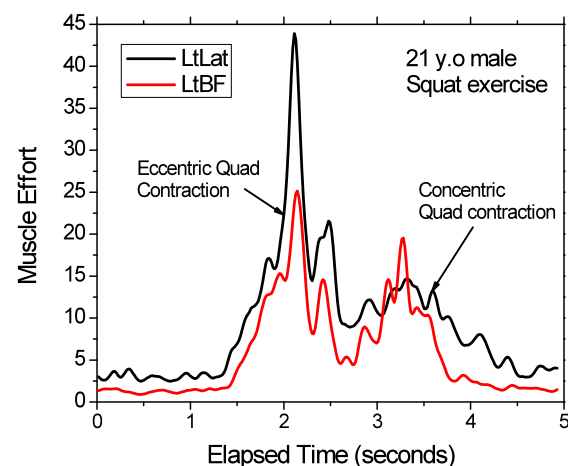
Data was sampled at 2 KHz and converted to muscle effort utilizing the BIOPAC AcqKnowledge VMG filter.

The data trains were low pass filtered (0.2 Hz) and the center point of the individual squat events were identified by the peak in this filtered data set. Using these epoch identification points, the 2.5 seconds before and after the center of the events were averaged using the unfiltered dataset for all ten individual squat events.

### Results:

Recordings from the left (uninjured) leg (*Figure 1*) demonstrate typical dominance of the lateralis during the eccentric contraction phase of the lateralis (squatting down), with good balance on the concentric phase (rising up).

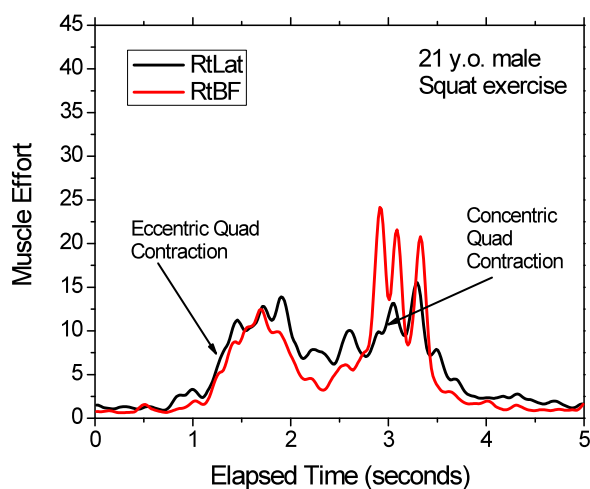
Interestingly, the left quadriceps does not appear to shut off during the rest phase, showing activity levels more than twice as high as the hamstring muscle during quiet standing. This is indicative of the subject “protecting” the injured leg while at rest.



**Figure 1.** Simultaneous VMG recordings from the left vastus lateralis and biceps femoris during squat exercise in individual with reconstructed ACL in right knee. High level of lateralis muscle

activity during quiet standing is indicative of individual favoring the right leg.

Recordings from the right (injured) leg demonstrate substantial quadriceps inhibition, even following six months of rehabilitation (Figure 2). The inhibition of the lateralis is particularly evident during eccentric contraction, but is also evident during concentric contraction where biceps femoris muscle effort is observed to exceed that of the lateralis.



**Figure 2.** Simultaneous VMG recordings from the right vastus lateralis and biceps femoris during squat exercise in individual with reconstructed ACL in right knee. Even following six months of rehabilitation, quadriceps inhibition is evident in the low levels of lateralis muscle effort during both the eccentric and concentric contraction phases of the squat.

### Conclusion

VMG provides a convenient means for assessing rehabilitation progress following sports injuries such as ACL tears due to its ability to be utilized under conditions which reflect the multi-segment, closed-chain activities associated with functional activities.

That VMG provides both an absolute and reproducible assessment of muscle effort permits both right/left comparisons within an individual, as

well as the opportunity to track rehabilitation progress over time where left/right comparisons are inappropriate or not possible. Further, VMG may have potential as a prescreening assessment to identify those individuals who are beginning their season with a distinct muscle imbalance, allowing appropriate strength conditioning exercises to be prescribed.

### References

Keays SI, Bullock-Saxon J, Keays AC (2000) Strength and function before and after anterior cruciate ligament reconstruction. *Clin Orthop* 373:174-183.

Pua, YH, Bryant AL, Steele JR, Newton RU, Wrigley TV (2008) Isokinetic dynamometry in anterior cruciate ligament injury and reconstruction. *Ann Acad Med Singapore* 37:330-340.