USE OF THE RACERMATE COMPUTRAINER IN THE REHABILITATION OF AN ANTERIOR CRUCIATE LIGAMENT (ACL) RECONSTRUCTION

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Abstract

Cyclists who undergo ACL reconstruction surgery are typically anxious to return to the bike. We believe that the athlete can return to riding faster by using an indoor cycling device called the CompuTrainer in their rehabilitation routine.

The therapy challenge is to restore their cycling ability quickly while protecting the ACL graft. In this study a standard ACL rehabilitation protocol was followed immediately after surgery for a 60 year old female. When the cyclist was able to free pedal on a stationary bike for 30 minutes we used the CompuTrainer device as an intermediate step in the transition back to road riding. The cyclist returned to actual riding within 11 weeks of surgery.

This paper reviews the rehabilitation protocol that was developed around the CompuTrainer for this cyclist and suggests the need to complete a controlled study in order to quantify how the CompuTrainer increases the speed and quality in restoring knee function.

Case Report

A 60-year-old female was skiing late in the first day of a skiing vacation. She said her right knee locked and she fell to the ground. Not feeling anything unusual she returned up the ski lift for another run.

On the second run she saw an approaching snowmobile and turned slightly to avoid it. Upon initiating the turn she heard a loud pop and then fell. Her ski came off and the ski patrol asked if she needed a ride down the mountain. After declining the ride she attempted to put her foot in the ski binding and heard a second pop.

She returned to her lodging, applied ice to the knee, and then returned to Denver the next day. Radiologic diagnosis of the knee revealed 80% tear of the ACL and damage to the meniscus. Surgery was recommended but she chose a course of rehabilitative therapy.

She performed a therapy protocol of leg presses, leg extensions, spinning, and more. She was able to ride a bicycle but experienced limited stability of the knee when she got off the bike. In this period she also went on a mountain climb. The climb presented no problem but the descent was painful and she had limited leg control. It was at this time, four months after injury, that she elected to have the ACL reconstruction surgery performed. The ACL graft was harvested from a hamstring tendon.

Post-operative therapy was delayed for two weeks due to finding osteoporotic bone at the graft attachment sites. Initially the cyclist had only 20 degrees of flexion. The hospital-directed physical therapy focused on reduction of swelling, restoring some flexibility to the knee joint, and achieving limited weight-bearing capability.

The second phase of rehabilitation started six weeks after surgery at a different facility. At this time the cyclist had approximately 90 degrees of flexion. The focus of this therapy protocol was to enhance knee extension, strengthen quadricep control, and develop an ability to pedal on a stationary bike with minimal resistance. The initial bike workout consisted of rocking the pedals back and forth, eventually pedaling backwards, then forward. Initial power output was 11 watts and ramped up to 25 watts over five minutes.

The third phase of rehabilitation started 10 weeks after surgery. The cyclist engaged a coach to workout on her actual bicycle and using the CompuTrainer. She continued her normal routine with the physical therapist. The workouts consisted of specific fixed resistance for a specific period of time. Unlike the road there is no unexpected additional resistance due to grade changes or wind.

The first session on the CompuTrainer was free-pedaling with minimal resistance to adjust for the differences between the stationary bike and her actual bike.

A major improvement in pedaling came during the second session when analysis of her spin showed that 70% of her total power output was from the injured leg. After using this session to balance the

power between her two legs we were able to double the total power to the rear wheel. The SpinScan feature of the CompuTrainer also indicates the contribution of power between the quadricep and hamstring muscles as Average Torque Angle (ATA).

After a week of training on the stationary bike concentrating on power balance between legs and force throughout the pedal circle the athlete was strong enough to participate in an actual road ride.

Discussion

The knee is one of the most complex joints in the human body and the anterior cruciate ligament (ACL) plays a major role in stabilizing the joint. It is easily damaged because it is small and susceptible to twisting. A damaged ACL is usually reconstructed using a graft from the patellar tendon or one of the hamstring tendons.

The main rehabilitation challenges after ACL reconstruction surgery are to minimize atrophy of the leg muscles, reduce swelling, restore flexibility to the knee joint, and protect the ACL graft until it matures.

Free pedaling on the bicycle requires a knee flexion angle of at least 120 degrees. However, restoring knee extension capability is done first to avoid the possibility of flexion contracture (the inability to extend the leg after flexing).

Early knee extension therapy establishes the foundation for the entire rehabilitation program. The incidence of flexion contracture with associated quadriceps weakness and extensor mechanism dysfunction following ACL reconstruction has significantly decreased with accelerated knee extension immediately after surgery. Quadriceps strength is enhanced with early extension and early weight bearing. Closed kinetic lower extremity strengthening facilitates improved patellar tracking and has been determined to be a functional mode of exercise. The combination of early knee extension, early weight bearing, and closed kinetic quadriceps strengthening allows the patient to progress through the post-operative rehabilitation period at a rapid pace with minimal chance of compromising ligamentous stability.[1]

Pedaling on a stationary bike may be attempted after the leg has attained adequate strength and flexibility to walk easily with minimal discomfort. At first the cyclist may only be able to rock the pedals back and forth. Next, they may be able to achieve a full circle by pedaling backwards. And finally after warming up they may be able to achieve full circles by pedaling forwards. For the typical cyclist this is a major milestone. And, they will be anxious to return to their actual bicycle.

The CompuTrainer by Racermate, Inc. was used as an intermediate step in the transition from stationary bike to real bike. This tool uses the cyclist's actual bicycle which is important for training leg muscles to their specific riding equipment. We replace the pedal clips with baskets to eliminate the twisting motion of clipping in and out of the pedals. The rotational stress on the knee places the ACL graft at risk.

Actual roads have uneven terrain that can result in unexpected levels of stress on the knees. With the CompuTrainer we have precise control over the resistance presented to the rider in one watt increments.

Spinscan™ displays the force applied to the pedal throughout the first half of rotation. Average Torque Angle (ATA) is also indicated to show the pedal angle where most of the torque is being generated (usually close to 90 deg).

Data is presented in a polar graph display. Perfect pedaling would result in a trace that is a perfect circle. However, most people pedal hardest through the 90 deg and coast through the top and bottom of the stroke which results in a pattern of two lobes. The relative size of each lobe indicates the power contribution from each leg. This is also displayed numerically.

ATA is a line indicating where in the pedal stroke the maximum torque is being delivered. This is averaged to smooth the display. The ideal ATA is at 90 deg with 95-100 deg being typical. At an ATA of 120 deg the majority of pedal force is being provided by the hamstring muscle as the pedal is being pulled through by the leg.

Together, Spinscan and ATA show you pedaling efficiency, the power that is developed in each leg, the relative effort of your different leg muscles, and more.

I have established an arbitrary criterion that cyclists should the goal of having their percent of power from each leg within 10% and their ATA at 105-110 deg before attempting an actual road ride. This should indicate adequate muscle balance to protect the ACL graft in the injured leg.

Conclusion

The CompuTrainer provided value in this ACL rehabilitation case, if for no other reason, than to alleviate the tedium of working out on standard physical therapy equipment. Not discussed here are additional features which include simulation of actual riding routes developed using the Delorme Topo USA software, detailed 3D graphics to display the route, a pacing figure to ride with, and numerous other biomedical parameters that are displayed during a session.

However, the true value of the CompuTrainer is the SpinScan capability to determine the power contribution from each leg and Average Torque Angle to indicate the power contribution from the quadricep and hamstring muscles which no other device can offer.

I am presenting this case not as an advertisement for the CompuTrainer, rather to suggest that this device may be an alternative to higher priced diagnostic equipment. And, to further suggest that it has features, not found in other devices that can quantify important biometric parameters which allow therapists and coaches to administer rehabilitation protocols more accurately.

Verification that the CompuTrainer indeed speeds patient recovery from ACL and other knee injuries, and the quantification of this progress compared to other therapy protocols awaits discovery through further research and study.

References

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