# The Razor Curl: A Functional Approach to Hamstring Training

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## Abstract

Oliver, GD and Dougherty, CP. The razor curl: a functional approach to hamstring training. *J Strength Cond Res* 23(2): 401–405, 2009—This study examined the effectiveness of a functional hamstring training exercise, the razor curl on conditioning the hamstring and gluteal musculature. Eight healthy, female intercollegiate athletes participated (mean age 20.8 ± 3.9 years; mean height, 177.8 ± 10.9 cm; mean weight, 67.3 ± 9.9 kg). Electromyographic (EMG) data were collected on the following muscles: medial hamstring (semimembranosus and semitendinosus), biceps femoris, gluteus medius, and gluteus maximus while participants performed the razor curl. The functional positioning of the razor curl showed maximum activation of the medial hamstring muscle group of up to 220% of its maximum voluntary isometric contraction (MVIC), just as the biceps femoris displayed a max of up to 140% of MVIC. Maximum activation of the hamstrings and gluteals were observed from the point of 90° of hip flexion to the point of knee flexion beyond 90°. These data reveal that the razor curl does indeed activate the hamstring musculature and based on the mechanics of the razor curl one can train in a more functional position. It is known biomechanically that flexing the hip allows for a lengthening contraction of the hamstring at the hip, thus allowing for a more optimal forceful contraction of the hamstrings at the knee. In conclusion, the razor curl hamstring exercise is designed to increase hamstring contractibility by placing the hip into flexion. By including strengthening the hamstring in a functional position one accentuates other land based training methods such as jump landing training in efforts to ultimately decrease the susceptibility of anterior cruciate ligament injury.

**Key Words** anterior cruciate ligament injury prevention, functional training, hamstring, hamstring strengthening

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## Introduction

Anterior cruciate ligament (ACL) injuries in sport continue to be the mystery of preventative measures in sports medicine. Noncontact ACL injuries commonly occur in sports requiring cutting, pivoting, sudden deceleration, and jumping (2,3,6,20). Women athletes involved in cutting, pivoting, and jumping sports are at a 4- to 6-fold greater risk of sustaining a noncontact ACL injury than their men counterparts (12). Researchers have constantly been fighting the never-ending battle of the great discrepancy of noncontact ACL injuries between men and women. It has commonly been accepted that environmental, hormonal, anatomic, and motor control factors all have been coined as proposed culprits of noncontact ACL injuries in women. Of all the proposed factors to injury, motor control issues are one of the easiest to modify (8,10,13,15). Motor control factors encompassing everything in the realm of biomechanical neuromuscular training have the propensity to play a major role in ACL injury prevention.

It has been documented that during athletic tasks of jump landings, women tend to display decreased knee flexion, increased quadriceps activation, decreased hamstring activation, and increased knee values compared with their men counterparts (4,5,7,16–18). Hewett et al. (8) have explained women as being quadriceps dominant during a majority of athletic endeavors including running, jumping, and cutting. Quadriceps dominance refers to the quadriceps firing or being activated first during activities where it would be more beneficial for the hamstrings to fire simultaneously or before quadriceps activation. If the quadriceps are dominant during athletic endeavors, there is decreased resistance to anterior tibial stress that is typically produced by the hamstring muscle group. The inability to resist anterior tibial stress automatically predisposes one to ACL injury. It has been demonstrated that men are less quadriceps dominant and thus have more functional timing of quadriceps and hamstring muscle firing.

When the hamstrings are weak, the appropriate timing of the firing is sacrificed. The hamstrings act to flex the knee and extend the hip. Primarily when the hip is flexed, the hamstrings undergo a lengthening contraction. However, if the hip is flexed, then the hamstrings have to be at optimal strength and have appropriate timing to contract maximally to allow for knee flexion. If the hamstrings are weak, then one will not have appropriate knee flexion. A prime example would be when jumping and landing. Ideally, when performing a jump landing, the individual lands in an athletic position of approximately 90° of hip and knee flexion. Typically, a functional athletic stance has both hip and knee flexion. If the hamstrings are weak or not firing appropriately to allow for knee flexion, then the individual lands with more of an extended knee vs. a flexed knee. Landing with an extended knee accentuates the quadriceps-dominant phenomenon. A straight-leg landing is indicative of the quadriceps being dominant, thus allowing for more anterior shear stress of the tibia.

Hewett et al. (8) have found that the peak flexor moments at the knee have been as great as 3-fold higher in men high school athletes than in women athletes landing from a volleyball block. Men showing more flexor moments display the fact that men use their hamstrings much more efficiently than their women counterparts on jump landings. Women athletes reacted to a forward translation of the tibia primarily with a muscular activation of the quadriceps muscle group; men athletes relied on their hamstrings more to counteract the tibial displacement through knee flexion (11). Jump landing with the knee in extension predisposes individuals to ACL injuries. It has been shown that with small angles of knee flexion (0–30°), the quadriceps contractions pull the tibia forward and increase strain on the ACL, especially without balanced knee-flexor cocontractions to decrease the strain (11).

For one to have dynamic stability of the knee, musculature of both the knee extensors as well as the knee flexors should be balanced, thus allowing for no shear stress placed on the joint. Without shear stress, no additional strain is placed on the ligaments of the knee. Houston and Wojtys (11) have reported knee activation patterns in response to anterior tibial translation in elite basketball and volleyball players. It was discovered that the women athletes responded to the anterior tibial translation by first contracting the quadriceps, whereas the men athletes and the men and women nonathletes responded by first contracting the hamstrings. In addition, Zeller et al. (22) have shown that women produce significantly greater total maximal activation of the rectus femoris compared with men. From the studies previously mentioned, it is suggested that women display a more quadriceps-dominant role of producing dynamic stability of the knee compared with men. The main problem that can arise as a result of the quadriceps-dominant role that women exhibit is an increase of ACL injuries.

So, we often try to develop ways to prevent ACL injuries. Preventing ACL injuries is of paramount concern, and often the focus is on motor control issues. As stated previously, motor control encompasses biomechanical and neuromuscular development. Proper jump landing techniques have been addressed and have been shown to improve landing mechanics. To break down the kinetic chain before the functional mechanism of landing, one has to address neuromuscular control and strength. Because women already seem more quadriceps dominant, the reasonable focus should be on the hamstrings and their functional development. If the research shows that cutting and jumping, or, more importantly, jump landings, are predisposing activities that often lead to noncontact ACL injuries in women, then shouldn't the training focus be more functional in nature? Training the hamstring muscle group in a more functional position would be ideal. Therefore, the purpose of this study was to explore modifiable factors in focusing on a more biomechanically functional hamstring exercise–the razor curl–in an attempt to reduce the incidence of noncontact ACL injuries.

## Methods

### Experimental Approach to the Problem

The goal of the experiment was to determine if the RAZOR curl hamstring exercise actually targeted the hamstring and gluteal muscle groups. Descriptive statistics were used to determine the effectiveness of the RAZOR curl hamstring exercise by examining the normalized EMG data as the average percent of maximum voluntary isometric contractions.

### Subjects

Eight healthy, women intercollegiate athletes (mean age, 20.8 ± 3.9 years; mean height, 177.8 ± 10.9 cm; mean weight, 67.3 ± 9.9 kg) participated in the study. The subjects all were involved in resistance training at the time of data collection. Before participation, subjects were informed of possible risks and signed a consent form approved by the University of Arkansas institutional review board.

### Instrumentation

Electromyographic (EMG) data were collected using 3M Red-Dot bipolar surface electrodes placed over 5 muscle bellies on each subject's dominant side according to the method of Basmajian and Deluca (1), with an interelectrode distance of 25 mm as per Hintermeister et al. (9) The muscles targeted were the medial hamstring (semimembranosus and semitendinosus), biceps femoris, gluteus medius, and gluteus maximus. Surface electrodes were chosen because they were noninvasive and could reliably detect surface muscle activity.

Before electrode placement, each subject's skin was shaved, abraded, and cleaned with alcohol. Adhesive 3M Red-Dot electrodes were placed over the muscle bellies and parallel to the direction of the underlying muscle fibers. To ensure proper electrode placement, manual muscle tests were performed through maximum isometric voluntary contractions (MVICs) based on the work of Kendall et al. (14) Three manual muscle tests were performed by a certified athletic trainer for a total of 5 seconds for each muscle group. The first and last seconds of each MVIC trial were removed from the data in an attempt to obtain steady-state results for each of the muscle groups. The manual muscle testing provided a baseline reading for which all EMG data were based.

### Protocol

After electrode placement, subjects had the protocol of the functional hamstring exercise, the razor curl, explained to them, and they viewed repeated demonstrations. Each subject performed several warm-up trials with verbal feedback on proper technique before trial recording.

After electrodes were placed on the skin and the manual muscle testing was complete, each subject performed 5 repetitions of the razor curl exercise. The razor curl has the total body extended and then requires the hips and knees to flex to 90° simultaneously with full contraction of the hamstrings to further the knee flexion. There was no time allotted for rest between sets. During the trials, the subjects were instructed on proper posture through verbal cues. In addition to EMG data, video data were also collected from a 90° lateral view to ensure appropriate technique and to event mark the trials. All trials were event marked for concentric (pull) and eccentric (push) phases.

### Electromyographic Analysis

A Myopac Jr 10-channel amplifier (RUN Technologies Scientific Systems, Laguna Hills, Calif) transmitted the EMG raw data at 60 Hz via a fiberoptic cable to the receiver unit. The EMG unit has a common mode rejection ratio of 90 dB. The gain for the surface electrodes was set at 2000. The EMG data were recorded, stored, and analyzed with the analog data-acquisition package of Peak Motus Software (version 9.0; Peak Performance, Englewood, Colo).

The subjects' EMG enveloped data were assessed. Mean maximum EMG reference values were calculated for each muscle within the phase. Five trials of EMG data for each subject were analyzed to determine average peak amplitudes for all muscles during each concentric and eccentric phase of the exercise.

### Statistical Analyses

Statistical analyses were performed using SPSS 15.0 for Windows. Means and standard deviations of the normalized EMG data were examined for each muscle's percent of their maximum voluntary isometric contraction.

## Results

The functional positioning of the razor curl showed maximum activation of the medial hamstring muscle group of up to 220% MVIC, just as the biceps femoris displayed a max of up to 140% MVIC. In addition to maximal activation of the hamstring muscle groups, a maximum activation of the gluteus maximus was also displayed. Descriptive data are presented in Table 1. Maximum activation of the hamstrings and gluteals were observed from the point of 90° of hip flexion to the point of knee flexion beyond 90°.

**Table 1.** Electromyographic data normalized and expressed as percentages of the contribution of electrical muscle activity of the MVIC for the pull phase of the razor curl.

| Muscle | Maximum % of MVIC | *SD* |
|---|---|---|
| Medial hamstrings | 220.00 | 66.08 |
| Biceps femoris (lateral hamstrings) | 140.00 | 33.87 |
| Gluteus maximus | 100.00 | 29.09 |
| Gluteus medius | 66.67 | 20.21 |

MVIC = maximum voluntary isometric contraction; *SD* = standard deviation.

## Discussion

Traditionally, one strengthens the hamstring by performing a prone leg curl. When performing the prone leg curl, one begins in a prone, extended position, with the hips and knees extended. The act of performing the curl is keeping the hip extended and only flexing at the knee. The prone curl does indeed target and strengthen the hamstrings. However, the issue of function in sport-specific situations is critical. Functionality is dependent on the sport in which one is involved or on simply putting the body in a position that mimics the sporting skill. Previously, one has trained the hamstrings in a prone position; however, the prone position is usually a dysfunctional position in a majority of athletic endeavors. In addition to the prone position, the issue of an extended hip should also be addressed. Biomechanically, to get greater activation of the hamstrings at the knee joint, one should address the issue of active and passive insufficiency. Ideally, there should be more of a stretch at the stabilized joint in an attempt to work more optimally at the active joint. Thus, to maximize hamstring strength, one would want the hips flexed at 90° so that maximum force can be produced at the knee joint.

Generally, one assumes an athletic stance: head up, back straight, hip flexed, and knees flexed throughout all functional activities. Thus, to promote functionality, one should train in a more biomechanically functional position. Training the hamstring with the hips in a flexed position conditions the hamstrings in a biomechanically functional position. The findings of Weinhold et al. (21) reveal that women's motor control strategies used during the stop-jump task may indeed place women at a higher risk than men, but these findings also suggest that motor control factors are likely to be the most easily modifiable factor with any of the injury-prevention efforts. The razor curl allows the individual to assume an athletic functional posture while optimally training the hamstrings. The razor curl begins in a position of hip and knee extension. Then, the individual progresses to

**Figure 1.** Starting position of the razor curl.

**Figure 3.** End position: hips should maintain 90° flexion and knees should be maximally flexed by full contraction of the hamstring.

a position of 90° hip flexion and 90° knee flexion. With the hips maintaining a position of 90° flexion, the knees continue to flex, with the hamstrings contracting to their maximum (Figures 1–3).

It should be noted that the medial hamstrings were the most active of all muscles analyzed. In clinical relevance, the largest and most anterior insertion on the tibia is the medial hamstring, thereby acting as the mechanism for reducing anterior tibial shear stress. The medial hamstring's anatomic insertion is along the anterior medial tibia, whereas the lateral hamstring (biceps femoris) inserts on the fibular head and IT band along the Gerdy tubercle, which provide for very weak anterior shear resistance because of their angle of insertion and functional position during activity. The importance of the medial hamstring insertion is that the very location of insertion is along the axis at which optimal ACL reconstruction tunnels are often positioned.

**Figure 2.** Halfway point at which the knees and hips are flexed to 90°.

Also of note is the activation of the gluteus maximus. The gluteus maximus is activated primarily in lateral movements. The gluteus medius and minimus are primarily active in anterior and posterior movements. So, basically, one's primary abductor is the gluteus maximus. A position of hip abduction is very protective for the ACL and helps prevent the hip from allowing the knee to enter the point of no return (hip adduction, knee internal rotation, and knee flexion with valgus). Thus, by targeting not only the medial hamstring but also the gluteus maximus, one may be conditioning for a more functional approach to decreasing the likelihood of ACL injuries.

## Practical Applications

It is known biomechanically that flexing the hip allows for a lengthening contraction of the hamstring at the hip, thus allowing for a more optimal, forceful contraction of the hamstrings at the knee. In conclusion, the razor curl hamstring exercise is designed to increase hamstring contractibility by placing the hip into flexion. When one places the hip into flexion while performing the razor curl exercise, one essentially allows oneself to train in a more functional athletic position. By including strengthening of the hamstring in a functional position, one accentuates other land-based training methods such as jump landing training in efforts to ultimately decrease the susceptibility of ACL injury. Therefore, for one to ultimately train the hamstrings in their most optimal functional position, the hips and knees should be in a position of 90/90 as displayed in the razor curl.

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