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Commentary

The opportunity to write a commentary may be viewed as being asked for a second opinion. A second opinion may agree with or disagree with the initial interpretation. This commentary is a discussion of only those concepts with which I disagree that were presented in the article.

The term static weight lift is misleading. A more accurate term for the exercise might be dynamic-static-dynamic weight lift. Because a subject performs an isometric contraction and concentrates intensely does not ensure that he will lift the weight through the maximum available range of motion. The ability to raise the weight through the available ROM also depends on whether enough innervated and cross-sectional areas of muscle tissue exists.

The authors suggest that active dorsiflexion and inversion of the foot prevent excessive tibial external rotation, resulting in a more medial displacement of the tubercle (tuberosity) and providing a beneficial effect on the valgus movement of the patella during knee extension. Although the authors cite the research of Olerud and Berg1 to support this concept, they do not mention that Olerud and Berg's research was conducted in a closed kinetic chain with the subject's foot on the ground. The modified quadriceps femoris muscle exercise program presented in the article appears to use an open-kinetic-chain type of activity. The biomechanics of tibial rotation and subtalar motion are distinctly different in an open kinetic chain as compared with a closed kinetic chain.6,7 If the knee is not in a closed pack position, then the motion of inversion of the foot may prevent excessive tibial external rotation. In an open kinetic chain, however, when the tibia is in the last few degrees of extension or the first few degrees of flexion, the tibial rotation is a function of the arthrokineametics of the knee joint and not of the position of the foot.4,5 The medial rotation of the tibial tubercle observed with inversion of the foot in an open kinetic chain probably is a function of femoral internal rotation that may result if the subject is instructed to rotate his foot inwardly.

The authors do not mention the reasons for exercising the knee in a closed kinetic chain in their discussion of their modifications of quadriceps femoris muscle exercises. Hungerford and Lennox10 have reported a biomechanical analysis demonstrating less patellofemoral contact stress from 30 to 60 degrees of knee flexion in a closed kinetic chain versus an open kinetic chain.5 As the knee flexes, patellofemoral-joint-reaction (PFJR) forces increase, but so does the patellofemoral contact area, which aids in the distribution of PFJR forces so that patellofemoral stress is decreased.7

Preliminary data also are available supporting the use of closed-kinetic-chain exercises for patients with anterior cruciate ligament (ACL) injuries.7 Using an in vivo strain gage, Henning et al demonstrated with values normalized to the individual that one of the activities that caused the greatest strain to be placed on the ACL was knee-extension exercises using a 20-lb weight boot in the range of full extension to 22 degrees of flexion.7 The ACL was subjected to much less strain during a half-squat exercise.

Perhaps, quadriceps femoris muscle exercises should be modified to include more closed-kinetic-chain types of activities such as the lateral or anterior step-up exercises.6,9 In my experience, if the patient is allowed to pronate during the lateral step-up exercise, the valgus knee angle is increased, which is believed to be detrimental to patients with patellofemoral disorders.10

In an open kinetic chain, patellofemoral contact stress is greatest from 55 degrees of flexion to full extension.6 The modification of the static weight lift proposed by the authors to be performed from 35 degrees of flexion to full extension in an open kinetic chain, therefore, is in the ROM that creates the greatest, and possibly harmful, patellofemoral contact stress. The authors suggest that the static weight lift may be initiated in greater degrees of flexion because it affords better patellofemoral osseous stability. The study of Hungerford and Lennox provides an alternative rationale for using greater degrees of flexion during open-kinetic-chain knee extension in that patellofemoral contact stress is less from 55 to 75 degrees of flexion.6 With open-kinetic-chain, knee-extension resistive exercise, therefore, the greater the degree of knee flexion, the less the patellofemoral contact stress.

In a qualified statement, the authors suggest that electromuscular stimulation is a valuable adjunct to quadriceps femoris muscle exercises for strengthening the vastus medialis oblique muscle. Although the validity of this statement cannot be proven because measuring in vivo the tension-generating capability of an individual quadriceps femoris muscle is impossible, I will assume that the vastus medialis oblique muscle can be strengthened selectively with knee-ex-
tension exercises and electromuscular stimulation that is applied appropriately. The method proposed by the authors involves administering the electrical stimulation while the subject is performing open-kinetic-chain exercise. A careful review of the available physical therapy literature, which documents an increased ability of muscles to generate tension as a result of electrical stimulation, reveals that the methods used involve stabilizing the distal end while stimulating the muscle.11 Whether the authors of this article used a similar method is unclear.

In summary, the authors should be commended for their efforts to share a quadriceps femoris muscle exercise program that is based on their clinical experience. They support their observations with the available professional literature and perhaps have provided an incentive to others to support or refute their contentions with data that have been gathered using rigorous scientific controls. The major shortcoming of the modified quadriceps femoris muscle exercise program proposed by the authors is that it has not discussed adequately the distinction between closed-kinetic-chain exercises versus open-kinetic-chain exercises.

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**Authors’ Response**

We thank Mr. Howell for his stimulating review of our article. When judging the worth of any article, the reader must consider the intent of the authors and evaluate whether the stated purpose of the article has been fulfilled.

In our years of clinical practice, we have treated thousands of patients who complained of pain when performing even the simplest quadriceps femoris muscle exercises. We have heard numerous reports of patients who were instructed to exercise despite the pain—the too commonly heard “no pain, no gain” scenario. We also have met many therapists who simply do not know what to do in this instance.

The purpose of our article, therefore, was to review our clinical experience with the described modifications and to propose theoretical explanations for our patients’ reports of less pain. The reader must not confuse the sharing of clinical experiences through a professional forum with laboratory research substantiated by statistical significance. Our sole intent was to share our clinical experiences.

Howell provides us with a lengthy discussion of open-versus closed-kinetic-chain activities or those activities that are performed with the foot free as opposed to the foot stabilized. We rely heavily on step-up exercises and partial-squat exercises in the more advanced stages of quadriceps femoris muscle rehabilitation, but again, a report of our results obtained with these methods was not the purpose of our article.

Howell states that the work of Olerud and Berg1 was conducted in a closed kinetic chain with the foot on the ground and, therefore, believes that it is an inappropriate reference. Their measurements of the Q angle with different positions of the foot actually were accomplished by three different methods: 1) a photographic method with the subject in a standing position, 2) direct measurement by a goniometer with the subject in a standing position, and 3) direct measurement by a goniometer with the subject in a supine position. Figure 5 of their article compares the first and third of these methods and indicates a correlation value of .71. We see from plotting the data of 12 subjects, and thus 11 degrees of freedom, that this correlation is significant to the .01 level, indicating that a definite relationship exists between measurements of the Q angle in the standing and supine positions.

Howell believes that our use of quadriceps femoris muscle exercises for patients with reconstructed anterior cruciate ligaments is inappropriate and places excessive stress on the new graft. The results of the study of Henning et al.,3 however, were based on the recordings from only two patients, hardly an adequate sample to justify the entire revision of a rehabilitation protocol that consistently has produced satisfactory results over the years. The half-squat maneuver was not even performed on one of the two subjects in Henning et al’s study.

In conclusion, we thank Howell for his interest in our article and for further discussing many of the concepts we have covered. If the major shortcoming of our article was the failure to distinguish between open- and closed-kinetic-chain activities, we will consider our stated goals to be fulfilled because that comparison was not the intent of our article.

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