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Patellofemoral Pain: Open vs. Closed Chain Exercises

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There has been a disagreement on the appropriate prescription of exercises for anterior knee pain. Closed chain exercises (i.e., the foot is in contact with a surface such as the ground or a metal plate on exercise equipment) are more functional (i.e., simulating "real" activities), and place less stress on the anterior cruciate ligament than open chain exercises. On the other hand, closed chain exercises may lead to increasing compressive forces on the patellofemoral joint (usually in greater degrees of flexion). Also, strengthening of the quadriceps (and purportedly the *vastus medialis obliquus*) has been suggested to be safest and most effective through the last 15-20 degrees of knee extension as an open chain exercise.

Some reports have indicated an exacerbation of symptoms for patellofemoral pain patients using open-chain exercises. Most of these assumptions have been based on biomechanical studies, often involving cadavers. Few studies on the clinical outcome of patients with patellofemoral pain placed on either closed or open chain exercise programs have been conducted. A recent study compared a group of 60 patients with patellofemoral pain randomized to a five-week program of only closed kinetic chain or only open kinetic chain exercises.¹ The criteria for inclusion were that there was either pain on direct compression of the patella against the femoral condyles, pain on resisted extension, tenderness to palpation of the posterior patella, or pain with the patellar inhibition test (i.e., pain with isometric contraction of the quadriceps with suprapatellar resistance by the examiner). Patients with other types of knee pain or past surgery were excluded.

Prior to beginning the exercise program, a 10-repetition maximum was determined as the baseline for the exercises. Participants were then instructed to train at 60 percent of their maximum. A new 10-repetition maximum was determined at the end of each week. The exercise program consisted of daily performance of three sets of 10 repetitions with a one-minute rest between sets.

The exercise program for the open-chain group was:

- quadriceps exercises (i.e., maximum isometric quadriceps contraction in full extension);
- straight-leg raises with patient supine short-arc movements (10 degrees of knee flexion to full extension);
- leg adduction exercises in a side-lying position, with each exercise held isometrically for six seconds, with a three second rest between repetitions.

The exercise program for the closed-chain group was:

- seated leg presses-one-third knee bends on one leg, then both;
- stationary bicycling;
- rowing machine exercises;
- step-up and step-down exercises; and
- progressive jumping exercises.

Both groups were instructed to perform hamstring, quadriceps, and gastrocnemius static stretching after each training session (i.e., three repetitions of a 30-second static stretch).

After the five-week training session, participants were advised to keep up their strength gains; however, no follow-up was made until three months later. The researchers' approach to outcome measure was extensive. They included both a subjective outcome assessment using a 100-mm visual analog scale. This was combined with a functional outcome assessment tool incorporating patient impressions of various tasks such as knee bends, stair-stepping, and jumping. Objective measures included muscle strength measurements using a Cybex 350 dynamometer at 60, 180, and 300 deg./sec. and muscle length measurements using a goniometer.

Results should that at both five weeks and three months, both groups demonstrated statistically significant improvement in pain and improvement in functional performance as compared to baseline measurements. Strength measures improved in both groups for the hamstrings and the quadriceps. There were minor differences for some functional activities, such as jumping for those performing the closed-chain exercises,

otherwise, most differences were minimal. This study suggests that both exercise programs can be effective in the treatment of patients with anterior knee pain with some possible small advantages to closed chain approaches.

Reference:

Witvrouw E, Lysens R, Bellemans J, et al. Open versus closed kinetic chain exercises for patellofemoral pain: a prospective, randomized study. *American Journal of Sports Medicine*. 2000;28(5):687-694.

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