

## Patellar Malalignment, Part III

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In this article on patellofemoral (PF) problems we will deal with the rationale of treatment based on our static and functional examination described in part I and II. The main purpose of the PF examination was to determine if the patellofemoral dysfunction was localized to the structure (abnormal femoral sulcus and patella contours determined by x-ray, abnormal patella height due to length of patella tendon causing alta or baja, genu valgum or varum) or secondary dysfunction due to peripheral problems such as atrophy or tightness of the tissues that insert into the patellar: vastus medialis obliquus (VMO), iliotibial band, vastus lateralis, tightness of the retinaculum or abnormalities originating from the hip to the feet. Mann<sup>1</sup> states that an intensive conservative six-month treatment program should be attempted before surgical intervention.

All of the biomechanical insults found on the examination discussed in the previous article require treatment if possible. It was stated that structural problems such as excessive genu valgum or femoral anteversion could only be treated from a compensatory point of view such as stretching or strengthening involved muscles or using orthotics. Correcting the flexibility of muscles such as the hamstrings, quadriceps, tensae fascia lata, gastrocnemius, hip abductors, medial and lateral hip rotators were mentioned.

Probably, the most significant muscle relating to patellar function is the VMO. As previously stated, the sole function of this muscle is to act as a medial stabilizer to the patella. There is normally more of a tendency for increased lateral knee forces on the patella. There is a normal valgus Q angle in which the pull of the quadriceps on the patella is directed slightly lateral. The knee normally has a more prominent lateral condyle to help the patella resist these lateral forces.

There should be a dynamic balance between the medial and lateral forces that stabilizes the patella throughout its range of motion. The EMG activity between the vastus lateralis and VMO are almost equal, especially in the last 30 degrees of extension,<sup>3</sup> although it has been found in patients with PF problems that the vastus lateralis fires before the VMO. The end extension range is probably the range where the knee requires most control by quadriceps contraction,<sup>4</sup> because during the last 20 degrees of extension the patella cannot depend on receiving the complete stabilization of the femoral sulcus. It is at this range that the quadriceps are performing their chief function as an eccentric decelerator. It is apparent that weakness of the VMO or tightness of the lateral retinacula will have an adverse effect on patella tracking. Abnormal tracking creates increased chondral changes. The VMO due to its location will be the first to show atrophy; it is also indicative of general quadriceps weakness, not only isolated VMO weakness.<sup>5</sup> If found to be weak or atrophied (see previous article), just strengthening this muscle often relieves many PF problems.

Before discussing the exercise procedures regarding the PF area, it is important to understand the effect of compression forces on the patella (patellofemoral joint reaction force) at different ranges of

knee motion. There are two sources of patellofemoral compression. One is due to the forces exerted by the quadriceps and the other is the force exerted by increasing the acuteness of the knee angle between the patellar tendon force and the quadriceps tendon force.<sup>6</sup> Both of these forces are increased with knee flexion of 90 degrees. As the angle of flexion increases the force increases. Therefore most of the exercises recommended for PF problems are never performed near the 90 degree knee flexion position.

Henry<sup>7</sup> feels that excessive progressive resistance exercises with the knees more than 45 degrees of knee flexion can produce retinaculitis or tendinitis. The usual exercises are straight leg raises, short arc terminal knee extension (patient sitting with pillow under the knee and extending from 20 to 0 degrees), and isometric quadriceps setting (patient contracts knee muscle holding knee in as straightened position as possible). A specific exercise for the VMO is a diagonal straight leg raise with the patient sitting on a table with thigh and leg flat (outstretched). The extremity should be positioned slightly lateral to the midline and the foot should be externally rotated. The patient lifts the straight laterally rotated extremity up and across the midline as if the knee were going towards the opposite shoulder. Besides strengthening the medial quadriceps, the hips flexors, adductors, and hip rotators are also exercised. Eventually weights can be added.

Hanten and Shane<sup>8</sup> show that the VMO can be selectively strengthened by performing hip adduction exercises alone since the VMO originates off the tendon of the adductor magnus and somewhat off the tendon of the adductor longus muscle. They feel that a "strong VMO originating from weak adductors would serve only to draw the adductor tendons toward the patella, having no effect in reducing the lateral malalignment."<sup>8</sup> Patients can be given a home exercise for the VMO. With the leg extended the patient pushes the patella laterally while attempting to contract the medial quadriceps. Patients can also push and hold the patella in a lateral to medial position to stretch the lateral retinaculum.

It has been found that the rectus femoris shows greater EMG activity during straight leg raises than during quadricep sets while the vastus medialis, gluteus medius, and biceps femoris showed greater activity during quadricep sets than during straight leg raises.<sup>9</sup> Quadriceps setting generates 40 percent more EMG activity in the VMO than during straight leg raises (SLR). Reilly and Marten<sup>10</sup> feel that compression of the patella on the femur normally occurs with the load coming from above and most exercises are performed with the load distal to the knee. Hughston<sup>11</sup> feels that the extensor mechanism is used as an extensor of the femur on the fixed tibia so that increasing the extensor strength by extending the tibia on the fixed femur is not functional. He feels that climbing hills is probably one the best exercises (providing knee flexion does not go past 50 degrees). With distal loading of the foot for quadriceps strengthening from flexion to extension, maximum forces with free weight are between 60 and 20 degrees,<sup>9</sup> a range that is not recommended.

Beckman et al.,<sup>12</sup> feel that all of the above exercises which are of the open kinetic chain type are not as functional as the closed kinetic (weight bearing type). They therefore recommend lunges (dueling position), stair downs (walking down stair exercises stressing the weight bearing knee) and partial squats (bilateral and unilateral), all of the above never flexing the knee more than 50 degrees flexion. Palpate the patella for crepitus when the patient does partial squatting so that the exercise is only performed in the noncrepitus range. Partial squat exercises are important during the first 10 to 30 degrees of flexion when the quadriceps are working at their chief function of deceleration. The patella

should also be evaluated and treated for loss of joint play.

In any acute PF problem it is important to reduce swelling before initiating strengthening type exercise because a swollen knee reflexly inhibits quadriceps contraction, causing atrophy and weakness.<sup>13</sup> Attempting quadriceps strengthening when there is effusion and pain is a waste of time and effort. PF rehabilitation protocol by Brunet and Stewart<sup>14</sup> includes isometric quad sets of 50 per hour, followed by straight leg raises (SLRs), eight sets of 10 lifts three times per day. The SLR are done with the noninvolved knee flexed to 90 degrees with foot next to outstretched involved knee. Patient contracts the knee muscles and raises involved leg up parallel with the uninvolved thigh. Patient holds for three seconds, lowers leg and rests for three seconds. Patient rests for one minute after each set of ten lifts. As soon as leg lifts become easy, free weights are added from one to fifteen pounds and added as soon as patients state that they are no longer fatigued.

Stationary biking could be used passively at first by using the good knee only. Later it can be used progressively by decreasing the seat height or increasing the pedaling force.

To decrease pain during exercise and walking, to increase the surface area of patella contact, to create a more even distribution of load, and to allow the muscles inserting into the patellar to function properly, the patella can be taped into a neutral position. It is necessary to take into consideration patella rotation based on which direction the inferior pole is rotated, lateral or medial tilt, medial or lateral glide towards the condyles, and finally superior and inferior tilting of the opposite poles.<sup>12,15</sup> Depending on the abnormal directions, the patella is taped towards the normal position. For a laterally positioned patella, tape from lateral border of patella and pull the tape medially. If the patella is tilted, tape from the middle of the patella and pull the tape (i.e., medially) to lift the lateral border of the patella. Taping also helps to influence the dynamic control of the patella. A Palumbo or Camp brace can also be used to help control the patella position during rehabilitation.

In conclusion, patella malalignment is the chief functional stress underlying many PF problems. A forceful quadriceps contraction on a malaligned patella eventually results in excessive chondral wear. Strobel and Stedfeld<sup>16</sup> state that "chondromalacia" should not be used as a diagnosis since it is really a "pathoanatomic and morphologic presentation of the cartilage." They feel that due to the complex nature of many PF problems that the best term would be "femoropatellar pain syndrome."

## *References*

1. Mann, R.A. "Biomechanics of the Foot and Ankle." In Mann R (ED): Surgery of the Foot, 5 ed. St. Louis, Mosby 1986.
2. Hammer, W.I. Functional Soft Tissue Examination and Treatment by Manual Methods: The Extremities. Gaithersburg, Maryland, Aspen 1991.
3. Reynolds L., Levin, T.A., Mediros, J.M., et al. "EMG Activity of the Vastus Medialis Oblique and the Vastus Lateralis in Their Role in Patellar Alignment." Am J Phys Med 1983; 62:61-70.

4. Delitto, A., Lehman, R.C. "Rehabilitation of the Athlete with a Knee Injury." Clin in Sports Med 1989; (8) 4:805-840.
5. Lieb, F.J., Perry J. "Quadriceps Function: An Anatomical and Mechanical Study Using Amputated Limbs." J Bone Joint Surg. 1968; 50A:1535-1548.
6. Frankel, V.H., Nordin M. Basic Biomechanics of the Musculoskeletal System. Philadelphia, Lea & Febiger 1989.
7. Henry, J.H. "Conservative Treatment of Patellofemoral Subluxation." Clin in Sports Med 1989; (8) 2:261-278.
8. Hanten, W.P., Schulthies, S.S. "Exercise Effect on Electromyographic Activity of the Vastus Medialis Oblique and Vastus Lateralis Muscles." Phys Ther 1990; (70) 9:561-565.
9. Soderberg, G.L., Minor, S.D., Arnold, K., et al. "Electromyographic Analysis of Knee Exercises in Healthy Subjects and In Patients with Knee Pathologies." Phys Ther 1987; 67: 1691-1696.
10. Reilly D., Martens, M. "Experimental Analysis of Quadriceps Muscle Force and Patellofemoral Joint Reaction Force of Various Activities." Acta Orth Scand 1972; 43:126.
11. Hughston, J.C. "Patellar Subluxation." Clin Sports Med 1989; 8:153-161.
12. Beckman M., Craig, R., Lehman, R.C. "Rehabilitation of Patellofemoral Dysfunction in the Athlete." Clin Sports Med 1989; (8) 4: 841-860.
13. deAndrade, J.R., Grant, C., Dixon, A.S. "Joint Distension and Reflex Muscle Inhibition in the Knee." J Bone Joint Surg 1965; 47A: 313-322.
14. Brunet, M.E., Stewart, G.W. "Patellofemoral Rehabilitation." Clin Sports Med 1989; (8) 4:319-329.
15. Arno, S. The A Angle: A Quantitative Measurement of Patella Alignment and Realignment." JOSPT 1990; (12) 6:237-242.
16. Strobel, M., Stedtfeld, H.W. Diagnostic Evaluation of the Knee. New York: Springer-Verlag,

1990.

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APRIL 1991