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Post-Surgical Rehabilitation of a 12-year-old Female Athlete After Medial
Patellofemoral Ligament Reconstruction

by

Jonathan E. Arntson
Master of Physical Therapy
University of North Dakota, 1998

A Scholarly Project

Submitted to the Graduate Faculty

of the

Department of Physical Therapy

School of Medicine

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for the degree of

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This scholarly project, submitted by Jonathan E. Arntson in partial fulfillment of the requirements for the Degree of Doctor of Physical Therapy from the University of North Dakota, has been read by the Advisor and Chairperson of Physical Therapy under whom the work has been done and is hereby approved.



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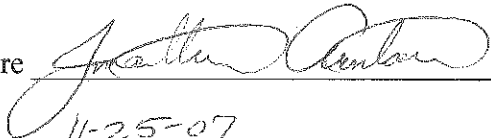
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 Medial Patellofemoral Ligament Reconstruction

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Degree Doctor of Physical Therapy

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ABSTRACT

Background and Purpose. The treatment of adolescents with lateral patellar instability has changed greatly in recent years. For surgical treatment of recurrent dislocation, the intervention of choice has become medial patellofemoral ligament (MPFL) repair or reconstruction. The purpose of this case study is to discuss recent trends in management of patients suffering from chronic patellar instability, and particularly to describe the post-operative management of this adolescent female who underwent medial patellofemoral ligament reconstruction. Case Description. Having failed a trial of conservative rehabilitation, a 12-year-old female athlete with a history of recurrent patellar dislocation underwent MPFL reconstruction. Her post-surgical rehabilitation program focused on early mobilization and quadriceps activation, progressing into a closed kinetic chain and proprioception focused regimen. Electrical stimulation to the quadriceps, biofeedback, passive range of motion, friction massage to scar tissue, and patellar mobilization were also employed. Outcome. The patient showed significant positive gains in range of motion, strength, proprioception, and function. She had no pain. She reported no feelings of patellar instability. Discussion. Despite the ongoing presence of other biomechanical risk factors, patients who undergo MPFL reconstruction typically report good to excellent outcomes and re-dislocation is uncommon. The rehabilitation regimen outlined in this case report appears to be efficacious.

Key Words: patellar instability, medial patellofemoral ligament, medial patellofemoral ligament reconstruction, closed kinetic chain exercise, proprioception, electrical stimulation, electromyographic biofeedback

CHAPTER I

INTRODUCTION

Until recently, the stereotypical adolescent with patellar instability was visualized as an inactive female, overweight, with general ligamentous laxity. Recent studies¹⁻⁴ have undermined this view. Findings indicated that most patellar dislocations occurred in athletically active adolescents and young adults between 14 and 20 years of age without a clear gender predilection.¹ These gender findings were slightly misleading, however, as Arendt² noted that studies suggested acute patellar dislocations occurred more frequently in males, while females tended to experience more recurrent instability. She cited the results of a recent prospective study by Fithian et al³ that found the highest incidence of patellar dislocation among females 10 to 17 years old, and established that patellar dislocators with a history of patellar instability were more likely to be female. Males were more likely than females to dislocate secondary to contact injuries. In the case of either gender, the primary risk factor was participation in high-level sports.⁴ This description accurately depicted the subject of this case study—a 12-year-old female basketball player with a history of recurrent patellar dislocation. The purpose of this case study is to discuss recent trends in management of patients suffering from chronic patellar instability, and particularly to describe the post-operative management of this adolescent female who underwent medial patellofemoral ligament reconstruction.

Conceptually, patellar stability can be thought of as a state of equilibrium of the biomechanics of the knee, with soft tissue restraints and bony conformity being balanced by the pull of the quadriceps, which typically has a lateral bias.¹ A disruption or abnormality of any one of these factors can result in patellar instability. There have been many lower extremity biomechanical abnormalities traditionally associated with patellar instability and the likelihood

of dislocation, including patella alta, torsional deformities of either the femur or tibia, increased Q angle, trochlear dysplasia, and muscle weakness and imbalance. While there remains general agreement that lower extremity biomechanics certainly seem to contribute to patellar instability, research has been inconclusive regarding the causative role these risk factors play.

Patella alta, or high-riding patella, has been most consistently associated with patellar instability in the literature.^{1,4-6} In normal knees, the patella enters the trochlear groove at approximately 20 degrees, at which point its stability is significantly improved by the buttressing effect of the trochlea. Patella alta increases the flexion angle at which the patella engages the trochlea.^{1,4} In the closed kinetic chain, patellofemoral joint reaction forces (PFJRF) increase with increasing degrees of knee flexion⁷; the combination of increasing PFJRF and late trochlear engagement contributes to instability of the patella. Research has also established trochlear dysplasia—which can be defined as the flattening of the femoral sulcus angle—as a relatively important contributor to patellar instability. Studies^{1,6} have found trochlear dysplasia in 29% to 85% of patients with patellofemoral instability. Dejour et al⁶ also found quadriceps dysplasia and excessive tibial tuberosity to trochlear groove distance to be risk factors present in the knees of those with patellar instability much more frequently than in normals. There is general agreement that patellar instability is multifactorial in nature, and the presence of multiple risk factors increases the likelihood of symptoms and dysfunction related to patellar instability. Any one risk factor, however, is not necessarily predictive.

Most recent studies^{1,5} agree that the essential clinical feature in establishing a diagnosis of patellar instability is excessive lateral patellar mobility. The primary static stabilizer of the patella is the medial patellofemoral ligament (MPFL), which provides 50%-80% of the medial stabilizing force of the patella.^{1,4,8} The MPFL attaches to the superior half of the medial border

of the patella and runs medially to the anterior aspect of the medial epicondyle, providing resistance to lateralization of the patella throughout the knee's range of motion.⁹ Recent studies^{1,4,5} have shown that with patellar dislocation, this ligament is ruptured in nearly all cases. The rupture of the MPFL typically results in excessive passive lateral displacement of the patella relative to the uninjured knee, and studies⁵ have shown that knees suffering patellar dislocation show increased patellar laxity compared to the knees of those with no history of instability. Lacking the primary static stabilizer of the knee, dislocators are subsequently quite susceptible to reinjury, with re-dislocation rates reported at between 15 and 44%, with 30% to 50% still suffering anterior knee pain two years after injury.¹ Recent reviews^{1,5} emphasize that the MPFL injury is now considered the essential lesion in cases of patellar dislocation.

Management of patellar instability problems in children and adolescents has varied widely over the years. Particularly in first-time dislocators, the treatment of choice in the United States generally remains conservative intervention.⁵ The failure rate for conservative treatment is 40%-50%, and its failure appears to be linked to the presence of the malalignment problems discussed above.⁸ The likelihood of success for conservative intervention is best for first-time dislocators who suffered a traumatic dislocation secondary to impact. For recurrent dislocators and those for whom conservative interventions have failed, surgery is necessary. Over 100 surgical procedures have been described in the literature.¹ Despite the wide variety of techniques, surgeons typically do 1 of 3 things—release tight lateral structures, restore medial restraints, or improve anatomical alignment.¹ In recent years there has been a movement toward repair or reconstruction of the MPFL as the surgical intervention of choice for patellar instability.^{1,4,5}

MPFL repair can be performed in the presence of a salvageable remnant; typically the MPFL ruptures at its femoral attachment, and can be reattached at the adductor tubercle.⁵ In most cases involving chronic instability and recurrent dislocation no patent remnant remains, and patients must undergo reconstruction.¹ In these cases, the MPFL is reconstructed through the use of a replacement graft—typically a semitendinosus tendon, a quadriceps tendon, or an adductor tendon.⁵ Outcome studies¹⁰⁻¹³ for MPFL repair and reconstruction have consistently shown good to excellent results.

No research has been reported in the literature regarding the most appropriate rehabilitation program following MPFL repair. Two reviews^{1,4} recommended early post-operative mobilization to avoid stiffness, pain and swelling control, and early quadriceps activation. An adjustable hinged brace was recommended to avoid extremes of flexion and valgus stresses at the knee.⁴ General recommendations were made for progressing from quadriceps isometrics and straight leg raises to more vigorous activities over time.^{1,4} In general, a patient can expect return to sports in 4-6 months.^{1,4} These general recommendations, while seemingly sensible, are not yet supported by research.

CHAPTER II

CASE DESCRIPTION

Examination, Evaluation and Diagnosis

The patient was an athletic 12-year-old female who had first suffered left patellar dislocation 2 or 3 years previously, and underwent rehabilitation at that time with good subsequent functioning for about 2 years. Five months prior to her appointment she had suffered 3 patellar dislocations in the span of 2 days while playing basketball. Thereafter she did well for 2 months, when she again dislocated while dancing at a wedding reception. These 4 dislocations led the family to once again seek an orthopedic consultation.

Her local orthopedic surgeon wished to try conservative management first, and referred her to our clinic for physical therapy to focus on exercise with a trial of patellar taping techniques. Significant findings at her initial physical therapy evaluation at that time included a protective flexed-knee gait pattern, excessive passive lateral patellar mobility, visual evidence of patella alta on the involved extremity, excessive lateral patellar tilt when compared to the right knee, and quadriceps atrophy with strength measured at "Good" per manual muscle testing. Treatment focused on improving quadriceps and particularly vastus medialis oblique (VMO) strength and neuromuscular control through isometric quadriceps sets, straight leg raise, and closed kinetic chain activities. Proprioceptive activities were also performed. Taping techniques were tried but failed to control patellar mobility and actually caused some discomfort. Strength was improved after 7 visits, but patellar instability remained unchanged. The patient was subsequently referred to a specialist and underwent MPFL reconstruction to improve patellar stability.

On the date of initial evaluation she was 19 days post-operative. She reported little pain since surgery, but she had been wearing an adjustable hinged knee brace locked at 15 degrees of flexion, and had generally not been moving the knee. She was cleared for partial weight bearing with bilateral axillary crutches. She had been performing intermittent quadriceps sets in the brace, but no other exercises. She was using no medications, and had no other relevant medical history.

Examination/Evaluation:

Gait. The patient was ambulating using a three-point gait pattern with bilateral axillary crutches, exhibiting minimal weight bearing on her left lower extremity. She was wearing the brace, still locked at 15 degrees, at all times.

Range of motion. Range of motion was measured in supine with a universal goniometer according to the procedures described by Norkin and White.¹⁴ The patient demonstrated a passive extension deficit of 10 degrees, with flexion limited to 50 degrees with pain felt in the medial knee region at end range. By comparison, her right knee demonstrated 5 degrees of extension and 155 degrees of flexion. Active range of motion was not measured as the patient was unable to generate any significant active movement at her initial visit. Measurement of passive and active range of motion of the knee has been shown to have high reliability when performed by a single tester, which was the case in this instance.¹⁴

Strength. Manual muscle tests were performed per the manual muscle testing procedures described by Kendall and colleagues.¹⁵ Initially, the patient demonstrated quadriceps femoris and hamstring strength of "Trace," able to minimally contract the muscles but unable to generate any significant motion at the joint. Manual muscle tests were not initially performed at the hip or

ankle. Research has shown that intrarater manual muscle testing is reliable.¹⁶ She was unable to perform straight leg raise without assistance.

Observation. Visual observation showed no noticeable change in patella alta compared to this patient's presentation prior to surgery, and she continued to evidence a "camel sign" as described by Magee.¹⁷ She was unable to assume sitting position with knee bent 90 degrees for observation of patellar position. The patient evidenced significantly decreased lateral patellar tilt compared to pre-operative levels; her tilt was now essentially equal to the right. With contraction of the quadriceps in full extension, she continued to exhibit excessive lateral tracking, but quite significantly decreased compared to prior therapy sessions. These observational tools, while routinely used by physical therapists, have not been proven reliable or valid. Her surgical incisions were healing well with no sign of drainage or infection. She evidenced moderate swelling, particularly in the peripatellar region.

Diagnosis:

The key examination findings were decreased right knee range of motion, very poor left lower extremity muscle strength and control, and an altered gait pattern with reliance on crutches and a brace for functional mobility. These findings were in large part due to the fallout of the patient's recent major knee surgery, with immobilization, swelling, and scar tissue proliferation possible complicating factors. Problems were established as follows: (1) significant weakness of left lower extremity with poor neuromuscular control of the quadriceps; (2) significantly diminished range of motion of the knee; (3) post-surgical swelling at the knee; (4) inability to fully weight-bear on the knee and reliance on crutches for ambulation; (5) inability to participate in typical recreational and physical educational activities of adolescence. The patient's diagnosis per ICD-9-CM was established as 836.3, "Dislocation of patella, closed,"¹⁸ while she fit physical

therapy practice pattern 4I: "Impaired Joint Mobility, Motor Function, Muscle Performance, and Range of Motion Associated With Bony or Soft Tissue Surgery."¹⁹

Prognosis and Plan of Care

The patient's long-term prognosis was excellent: we anticipated full return of functional range-of-motion, strength, and proprioception, with ultimate return to competitive athletics. Based upon the evaluation and this patient's active athletic lifestyle, the following long-term goals were formulated to be achieved in 2 to 3 months: (1) reports of no significant pain in the knee with increasing level of activity as allowed per tissue healing constraints; (2) demonstration of left knee active range of motion within normal limits; (3) demonstration of "Normal" strength throughout the left lower extremity; (4) no reports of patellar instability or apprehension with improved patellar tracking demonstrated; and (5) independence in her exercise program to continue on her own as appropriate. As stepping stones toward those goals, the following short-term goals were established to be achieved in 2 to 3 weeks: (1) demonstrate improved left knee ROM, minimal extension deficit, with flexion exceeding 90 degrees; (2) demonstrate improved quadriceps control, able to perform a good quad set, with strength approaching 3+ to 4/5 range; (3) evidence continued excellent healing and diminishing swelling at the knee; (4) demonstrate improving weight-bearing capacity on the leg, with decreased support of brace/release of brace to allow for knee motion; (5) tolerate and perform home program regularly as prescribed.

Intervention

The patient's surgeon (Dr. Elizabeth Arendt, written communication, December 2005) had provided a written protocol to guide rehabilitation (Appendix A). This protocol reflected the general guidelines outlined above, with an emphasis on early mobilization and quadriceps activation, progressing to closed kinetic chain activities and other exercise as able.

Proprioceptive activities were also emphasized. Again, as noted above, no specific research regarding the efficacy of these post-surgical programs has been reported. Much study has been performed, however, regarding closed versus open kinetic chain activities in rehabilitation. In general, there is agreement that closed chain activities decrease patellofemoral stresses in the functional range of motion, and also include a proprioceptive component that open chain activities lack.²⁰ Decreased patellofemoral stresses as we transition post-MPFL reconstruction patients into more vigorous exercise should be beneficial. A study by Stensdotter et al²¹ also found that in closed kinetic chain exercise, we see a simultaneous recruitment of all 4 portions of the quadriceps muscle, while with open chain activities the rectus femoris was activated first, with the VMO being activated last. To maximize patellar stability, early activation of the VMO—the primary medial dynamic stabilizer of the patella^{1,4}—would clearly be advantageous. Rehabilitation programs aimed specifically at improving VMO recruitment, control, and strength have been a mainstay of patellofemoral pain and patellar instability regimens for several years. And while practitioners continue to report success with these programs, studies have never indicated that specific isolation of the VMO is possible.¹ These regimens' success may stem simply from the fact that they focus on whole quadriceps recruitment and strength. As pertains to the proprioceptive component of this protocol, research has established that joint proprioception of the knee suffers with injury, especially in relation to ACL deficiency.²² Studies²² also indicate that females in particular exhibit proprioception and neuromuscular control deficits that put them at a higher risk of knee injury. A post-operative exercise program for any knee surgery must include a proprioceptive component to minimize risk of reinjury. The following table (Table 1) outlines this patient's exercise progression on a weekly basis.

Table 1.
Exercise Program Progression.

Week Number	Number of visits	Exercise Addition and Progression
1	2	Add quad sets, hamstring sets, flexion SLR with assist, ball squeeze, supine extension stretch, heel slide, weight transfers
2	1	Add closed chain knee extension with theraband (CC ext); SLR flex, ext, abd, add with theraband; stationary bicycling
3	2	Add leg press; increase theraband resistance with CC ext and standing SLR exercises
4	1	Add single-leg leg press, squat, wall slide; increase CC ext and leg press resistance
5	2	Add prone hamstring curl with weight, double-leg toe raises, weight shift with knee bend, step-ups with 2" step; independent flexion SLR; increase CC ext, standing SLR, and leg press resistance
6	2	Add single leg toe raises, balance board double-leg lateral tilts and balance; increase standing SLR, hamstring curl, and leg press resistance
7	2	Add single leg balance, single leg balance with 2 lb. medicine ball, lunges, cable column walkouts, hamstring curl on Cybex machine; increase flexion SLR, CC ext, leg press, and hamstring curl resistance; increase step height to 4"
8	1	Add single leg squat, BOSU ball single leg balance, treadmill walking forward and retro; increase CC ext, cable column walkout, leg press resistance; increase step height to 6"
9	1	Add single leg balance with upper extremity motion, increase SLR flexion and medicine ball resistance; increase treadmill speed
10	1	Add sliding board; increase SLR flexion, Cybex hamstring curl, cable column walkout and leg press resistance; increase step height to 8"
11	1	Reviewed and performed discharge home exercise program

In addition to her exercise program, the patient received electrical stimulation to the quadriceps to stimulate muscle contraction and electromyographic biofeedback to the quadriceps to improve neuromuscular control. Electrical stimulation coupled with exercise following knee surgery has been shown to increase quadriceps strength faster than exercise alone.²³⁻²⁵ Biofeedback has been shown to increase quadriceps muscle torque and enhance neuromuscular recruitment,²⁶ and in a study by Draper and Ballard²⁷ was found to be more effective than electrical stimulation in facilitating the recovery of quadriceps strength and control. In this case, I chose to use electrical stimulation in the very early phase of this patient's rehabilitation when her quadriceps recruitment was quite poor, and this amounted to just the first week of physical therapy (2 visits). I employed biphasic current, with a pulse rate of 50 pulses per second and a pulse width of 200 microseconds. For her first visit, I used a 10 second contraction time followed by a 30 second rest time for a total of 10 minutes, with the intensity set to visual and palpable contraction and the patient performing an active quad set in conjunction with the stimulation. At her second visit, all parameters remained the same with the exception that I

progressed to a 10 second contraction time and a 10 second rest time to increase overall time of contraction. I transitioned to biofeedback as her ability to independently generate a meaningful, readable contraction improved, and used biofeedback for 5 weeks (10 visits). Biofeedback was performed with the use of a Prometheus Pathway TR-10 single-channel surface EMG unit, which offers auditory and visual feedback corresponding to the level of electrical activity in a muscle. The electrode was placed at the VMO, with the patient performing maximal quadriceps sets for 5 seconds followed by a 10 second rest for a total of 5 minutes. In week 7, she was progressed to 10 second contractions and 10 second rest periods. Biofeedback was discontinued in week 8.

This patient also received friction massage to scar tissue, passive range of motion (PROM) into flexion and extension, gentle manual stretching of the knee into flexion, and patellar mobilization in the superior, inferior, and medial directions. These interventions were aimed at providing early mobilization to the joint to avoid joint fibrosis and scar tissue adhesions and gradually increase range of motion—particularly early as the patient was unable to generate significant range of motion actively. She received PROM and manual stretching for 5 weeks (10 visits) and patellar mobilization for 6 weeks (12 visits). They were discontinued when patellar mobility was deemed normal, the likelihood of adhesion was minimal, and her active exercises were sufficient for continued range of motion gains and scar tissue remodeling. While these interventions are physiologically sound as early mobility tools through the first stages of healing, no known scientific study of their efficacy has been performed.

Her home exercise program consisted of all exercises performed in the clinic that could be performed at home with minimal equipment (including leg weights, theraband, step). Initially her exercise program was to be performed twice daily, decreasing to once daily in week 4 as her program became more vigorous and time consuming. For the first 3 weeks, the patient's parents

performed passive ROM as instructed in the clinic. Patient and family education was integral to her rehabilitation program, with additional topics covered including the anatomy and physiology of her surgery and the expected aftermath, the use of cryotherapy for pain and swelling control, and scar tissue and patellar mobilization techniques for home performance. The patient and her parents confirmed her home program compliance verbally.

Outcomes at Discharge

This patient was seen for a total of 16 visits over an 11-week period. She evidenced significant improvements in range of motion, strength, and proprioception over this time. From the initial measurements noted in the Examination/Evaluation section above, her PROM measured 5 degrees of extension and 133 degrees of flexion at the time of discharge, improvements of 15 degrees extension and 83 degrees of flexion. Her left knee extension was equal to the right; her left knee flexion was still 22 degrees short of the right, but was improving each week with exercise (Table 2). Her final active range of motion measurement for flexion was 131 degrees. She demonstrated no significant active anti-gravity extensor lag with straight leg raise, but still lacked eight degrees when extending from 90 degrees of flexion in a sitting position.

Table 2.
Passive range of motion and active flexion range of motion measurements.

Week	Passive ROM	Active flexion ROM
1	0-10-50	Not measured
2	5-0-70	64
3	5-0-98	91
5	5-0-111	108
6	5-0-120	118
7	5-0-125	123
9	5-0-131	127
11	5-0-133	131

The patient's quadriceps strength at final evaluation measured "Good," while hamstrings measured "Good+." She demonstrated "Normal" strength throughout her other lower extremity musculature. Her functional strength was considerably improved, and she was able to perform a vigorous program of exercises including eight-inch steps ups, leg press of 120 pounds, wall slides, lunges and squats. She reported no functional deficits at home or school, with the exception of non-participation in physical education or other sports activities due to continued physician's restrictions. Proprioception, while not specifically measured, had considerably improved from initial inability to bear weight, to performing single leg balance activities while catching four- and six-pound medicine balls as well as performing single leg balance on a platform for one minute.

The patient's gait pattern with walking was normal. Her hinged brace was fully opened during week 2, she discontinued the use of crutches in week 4, and progressed out of her hinged brace in week 8. She had not yet resumed running activities and thus these were not assessed. She had minimal to no swelling; the patient's surgeon had noted that it is typical for the knee to look "big" for a period of time after surgery partially due to surgical dissection of the soft tissue envelope surrounding the knee, and that was the case with this patient. She had no pain. She reported no feelings of patellar instability.

No clinimetric tool was used to assess this patient's functional gains, however the use of such an assessment would be beneficial in tracking objective functional progress. Perhaps the most applicable clinimetric would be the Lysholm Knee Rating Scale,²⁸ which was developed for measuring disability in patients with knee ligament injury. In the form of a 5 minute questionnaire, it is easy to administer and easy to score. Tegner and Lysholm²⁸ found both intra-

rater and inter-rater reliability of the Lysholm Knee Rating Scale to be excellent, while validity studies²⁸ indicated that it is an accurate measure of knee function.

The patient had completed her post-operative rehabilitation per the protocol after 11 weeks of physical therapy. At that time she had fully achieved 3 of the 5 long-term goals outlined above, and had partially achieved the goals of demonstrating “left knee active range of motion within normal limits” and demonstrating “‘Normal’ strength throughout the left lower extremity.” Her status and rate of gain were deemed sufficient for her to continue independently with a home exercise program with the likelihood that these goals would be fully achieved on her own. She was discharged from physical therapy to a home program consisting of heel slides with gentle flexion stretching, flexion SLR and hamstring curls with weight, closed chain knee extension exercise with theraband, single leg squat, double leg squat, wall slides, lunges, lateral lunges, eight-inch step ups, single leg balance activities, lateral shuffle, and stationary bicycling. She was to follow up with her physician within the next few weeks for ultimate release from restrictions. The patient and her family expressed satisfaction with her post-surgical outcome, and she was eagerly looking forward to returning to active recreational pursuits.

CHAPTER III

DISCUSSION/REFLECTION

Discussion

This patient, who had failed conservative treatment for patellar instability, has done quite well thus far following MPFL reconstruction. As a person with multiple malalignment problems and a history of multiple dislocations, she had no viable conservative options that would allow her to continue her active lifestyle. Her rehabilitation followed a clear trajectory of improvement without complication. The initial focus on mobilization, ROM and quadriceps activation resulted in quick ROM gains and improved quadriceps control and stability. This allowed for progressions in gait and more vigorous exercise, progressing to closed kinetic chain activities as soon as able to facilitate whole quadriceps recruitment as well as functional and proprioceptive return. The closed chain focus also protected the patellofemoral joint from excessive patellofemoral joint reaction forces. The phases of the protocol served as guides to keep exercise vigor within reasonable tissue healing constraints.

MPFL reconstruction restored this patient's medial static stability without significantly altering her other malalignment problems. While this does raise some question whether she will remain at increased likelihood for dislocation due to biomechanical risk factors such as patella alta or trochlear dysplasia, studies indicate that rates of re-dislocation following MPFL reconstruction are low. A recent study by Steiner et al¹⁰ focused specifically on patients with uncorrected trochlear dysplasia who had undergone MPFL reconstruction; this study found that 34 patients had suffered no post-surgical dislocations at an average follow-up of 66.5 months. Deie et al¹¹ found that there were no patellar dislocations after MPFL surgery in a long-term

study of 43 patients. It appears that despite the continued presence of other biomechanical risk factors, dislocation after MPFL reconstruction is uncommon.

While certainly in need of more rigorous study, this study suggests that the rehabilitation approach taken in this case is an effective post-surgical regimen following MPFL reconstruction.

Reflection

This patient experienced a positive outcome, and has gone on to once again participate normally in school and recreational activities. Generally, I feel the decisions I made in her rehabilitation were appropriate, and many of the measures and interventions employed are well supported by research as discussed above. I had never seen a patient following this type of procedure previously, but I feel comfortable working with fairly complex orthopedic problems, I had worked with the patient previously and was familiar with her case, and I performed research prior to seeing her in the clinic post-surgically which offered some insight into the procedure performed. A protocol was also provided by the referring physician, which further guided my decision to accept this patient for care. Post-surgically, no concerns arose over the course of her rehabilitation that led me to consider referral. I had extremely good communication with her orthopedist via e-mail, so any questions or concerns could be addressed immediately. Based upon this case study, a decision-making algorithm has been developed to guide post-surgical rehabilitation of patients who have undergone MPFL reconstruction (Appendix B).

One evaluation tool I would employ if I were to see a similar patient again in the clinic would be a clinimetric or functional outcome scale as discussed above. Specifically, I would administer the Lysholm Knee Rating Scale.²⁸ Administered bi-weekly, this test would have afforded me a better glimpse into the functional gains—or decrements—the patient was

experiencing in her daily life, and allowed me to easily document that change in a directly measurable form.

As for additional interventions, I would incorporate more core stability activities into her program in addition to the lower-extremity directed exercises. While I have thus far been unable to uncover research published on the topic, there have been discussions in the orthopedic community regarding the seeming correlation between poor core stability and knee ligament injuries. It certainly stands to reason that a stronger, better-controlled pelvic and hip girdle would accentuate whole lower-extremity stability, and thus decrease the likelihood of injury. This assertion has not yet been proven by research.

This patient was seen for a total of 16 visits over 11 weeks, at a total billed cost of \$3,224, or \$201.50 per visit. Her average time per visit was 54 minutes, which resulted in typical charges of 2 units of therapeutic exercise, 1 unit of neuromuscular reeducation, and 1 unit of manual therapy. The patient's total charges after insurance-related adjustments were \$2,119.97, or \$132.50 per visit. The physician's protocol called for 12 to 22 visits over a 12-week period of rehabilitation, and this patient's total of 16 fit squarely into those criteria. The cost of therapy—and units charged per visit—were justified by the time spent with the patient.

Were those costs justified by the outcome? This patient had an excellent outcome overall, and has returned to normal function. The patient and her parents verbalized satisfaction with her treatment and outcome, despite the fact that their insurance had a large deductible and they were forced to pay the bill incrementally over time. If the long-term success of this procedure is as good as the statistics cited above indicate, this intervention will have proven to be a good investment in avoiding the repetitive knee problems that almost certainly would have

beleaguered her for years down the line. A well-timed, successful intervention in her middle-school years should allow her to avoid an ill-timed, much more costly intervention as an adult.

Appendix A

Post-Operative Patellar Realignment Protocol

The Patellar Realignment Protocol is a goal-directed rehabilitation guideline with which patients will progress toward return to full functional and sport related activities. As you can see, the protocol is divided into phases which cover a time span of 3 months following surgery. Each phase is governed by specific goals which should be attained prior to advancement into the next phase.

These guidelines are based on healing in an ideal patient and outlines the earliest that specific activities are allowed. This is important for proper healing and remodeling of the surgical site.

All patients will not progress at the same pace. Individual variations will occur. Remember that protocol is only a guideline and specific time factors may vary depending on each individual's response.

Patients will progress only with the approval of their MD and physical therapist. Follow up visits will be made regularly with the physical therapist.

PHASE 1: 0-3 weeks; 1 x week

Dressing: 1st visit will consist of wound check and dressing change. Steri-strips will be removed and replaced. Keep these applied 10-14 days. Tubigrip stocking will be used to minimize swelling if necessary.

Gait: PWB with bilateral crutches until physician orders WBAT. You may stand without the crutches.

Brace: Brace will be worn at all times (when up and when sleeping) locked at 15 degrees of flexion. PROM allowed out of brace at home.

Exercises: Quad sets (do with NMES and/or biofeedback as needed)
Ball squeezes
SLR (with brace)
PROM in clinic: CPM 0-90_
PROM at home: (use CPM if needed): week 1-2 limit to 60_ flexion, week 3 advance as tolerated.
Emphasize full extension.

Goals: PROM: 0-90_
Strength: good quad set
SLR independently with brace

PHASE 2: 3-6 weeks; 1-2 x week (depending on quad control and access to alternative exercise setting)

Gait: Continue PWB with crutches and brace

Brace: Fully open
 May be removed indoors with adequate quad control; continue PWB
 Always wear out of doors

Exercises: ROM: active assisted, active
 SLR without immobilizer/brace (allow no lag)
 Stationary bike
 Leg press to body weight
 Double leg standing closed kinetic chain exercises
 Use of pool for AROM; swim with board between legs, arm pulls only
 Open kinetic chain hip pulls with tubing on involved limb. WB on uninvolved
 Begin seated BAPS; PWB
 Begin abdominal stabilization exercises (Lower abs/glutes/hamstrings)

Goals: ROM: 120_
 Strength: SLR independently without brace and no lag x 20

PHASE 3: 6-12 weeks; 1-2 x week

Gait: Advance to FWB without brace as strength and ROM allows. D/C crutches

Brace: Transfer to knee sleeve when out of brace.

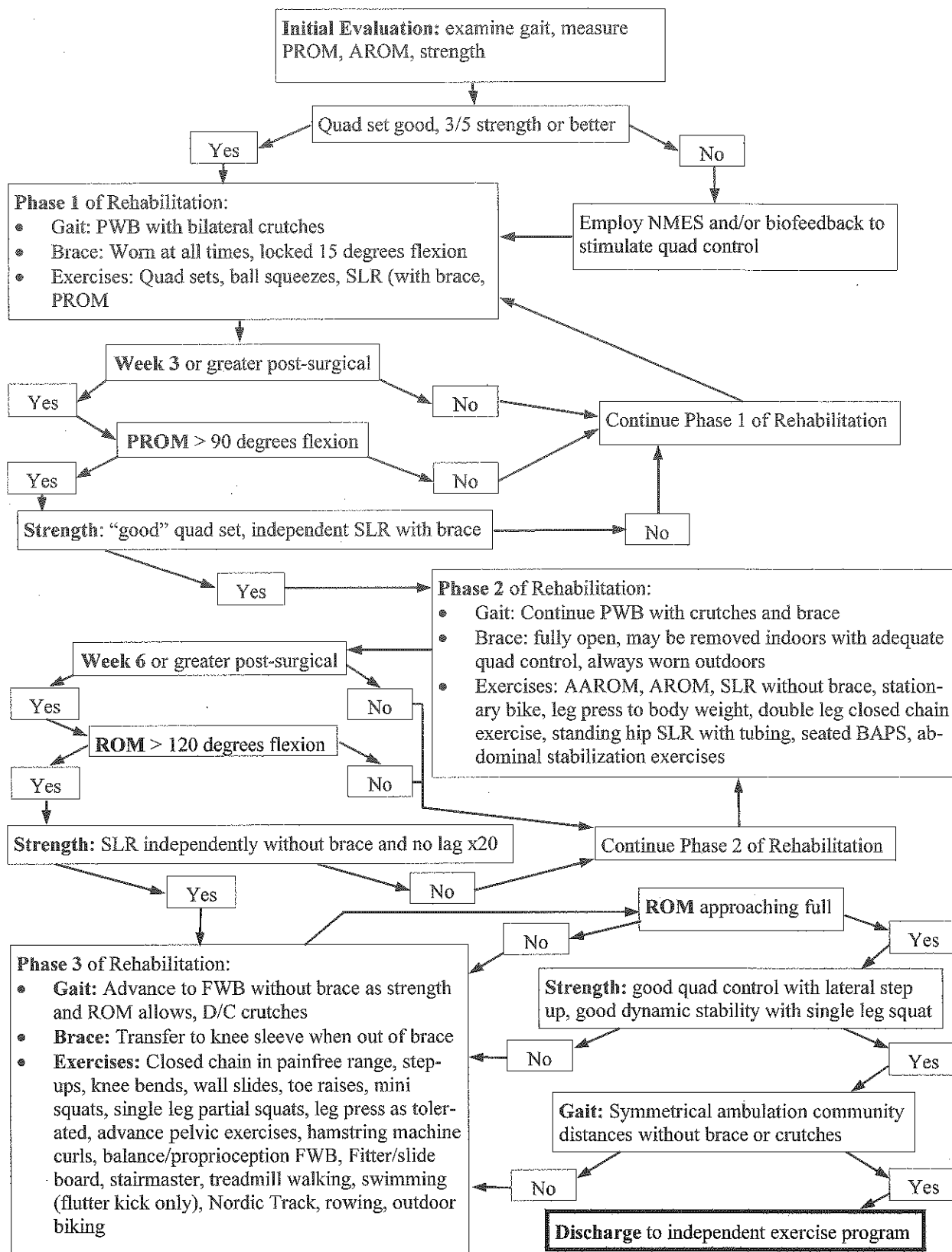
Exercises: Increase closed kinetic chain exercises in painfree arc of motion.
 Lateral and front step-ups
 Knee bends
 Wall/ball squats
 Toe raises
 Mini squats
 Single leg partial squats
 Increase weight on leg press as tolerated
 Advance pelvic exercises: (Swiss ball stability ex, advanced bridging)
 Begin hamstring machine curls
 Begin balance/proprioception FWB
 Fitter/Slide board
 Stairmaster
 Treadmill walking
 Swimming permitted, flutter kick only
 Nordic Track
 Rowing
 Outdoor biking

Goals: ROM: full
 Strength: Good quad with lateral step ups

Good dynamic stability with single leg squat and
contralateral movement
Gait: Symmetrical ambulation community distances without
braces/crutches.

Appendix B

Post-MPFL Reconstruction Protocol Algorithm
Jonathan Arntson, PT



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