

Treatment of Lateral Knee Pain Using Soft Tissue Mobilization in Four Female Triathletes

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Study Design: Prospective case series.

Background: These case reports present results of the treatment of lateral knee pain in four female amateur triathletes. The athletes were referred to the author's clinic with either a diagnosis of iliotibial band friction syndrome or patellofemoral pain syndrome, all four having symptoms for longer than seven months. Changes in training routines were identified as the possible cause of the overuse injuries that eventually developed into chronic conditions.

Intervention: Treatment involved soft tissue mobilization of the musculotendinous structures on the lateral aspect of the knee.

Results: At four weeks, three of the athletes improved 9 to 19 points on the Lower Extremity Functional Scale, 3 to 5 points on the Global Rating of Change Scale, and demonstrated improvement in hamstring and iliotibial band flexibility. At eight weeks the Global Rating of Change for these three athletes was a 7 ("a very great deal better") and they had returned to triathlon training with no complaints of lateral knee pain. One athlete did not respond to treatment and eventually underwent arthroscopic surgery for debridement of a lateral meniscus tear.

Conclusions: After ruling out common causes for lateral knee pain such as lateral meniscus tear, lateral collateral ligament sprain, patellofemoral dysfunction, osteochondral injury, biceps femoris tendonitis, iliotibial band friction syndrome or osteoarthritis, soft tissue restriction should be considered a potential source of dysfunction. In some cases soft tissue restriction is overlooked; athletes go undiagnosed and are limited from sports participation.

KEY WORDS: triathlete; lateral knee pain; soft tissue restriction; mobilization

INTRODUCTION

Triathletes undergo vigorous training regimens that may result in overuse injuries. Gosling and colleagues

reviewed twenty-two relevant papers and determined that lower limb injuries account for the majority of injuries in triathlon⁽¹⁾. Within the lower limb, knee injuries have been predominant with rates ranging from 14%–63%^(2,3,4).

Common causes of lateral knee pain include lateral meniscus tear^(5,6), lateral collateral ligament sprain^(6,7), patellofemoral dysfunction^(8,9), osteochondral injury^(6,10), biceps femoris tendonitis^(11,6), iliotibial band friction syndrome^(12,13,14), and osteoarthritis^(15,6). Very few references include myofascial pain syndrome as a source of knee pain, and the contributions of trigger points to knee dysfunction are generally not appreciated⁽¹⁶⁾. A correlation between lateral tightness and lateral knee pain has been identified in previous studies^(17,18).

Lateral knee pain suffered by triathletes frequently is caused by repetitive stress, from cycling and running to the musculotendinous structures that surround the knee^(2,1,19). The trauma to the musculotendinous structures can potentially cause bleeding and/or swelling between the tendons and surrounding tissues. Microadhesions that develop from this type of soft tissue trauma can influence tissue mobility, alter neurodynamics, and limit joint range of motion^(20,21,22,23). The result is a continuous cycle of restricted mobility that eventually influences overall function⁽²⁴⁾.

Training errors or changes in training routines that have been implicated in overuse knee injuries sustained by triathletes include excessive mileage⁽¹⁹⁾, a sudden increase in mileage^(12,13), an abrupt change in training surfaces⁽³⁾, hill work^(13,19), riding in a gear that is too high with a low cadence^(25,19), equipment changes^(13,19), and high-level participation without an adequate training base⁽¹³⁾. Bicycle fit^(13,19), running shoes⁽²⁶⁾, and running technique are also potential causes for injury.

The following is a report of four female amateur triathletes who were referred to the author's physical therapy clinic with chronic lateral knee pain with persistent symptoms lasting longer than seven months.

METHODS

Participants

Four female amateur triathletes, ages 27–43, developed pain around the right lateral femoral condyle (Figure 1) as a result of a change in their training

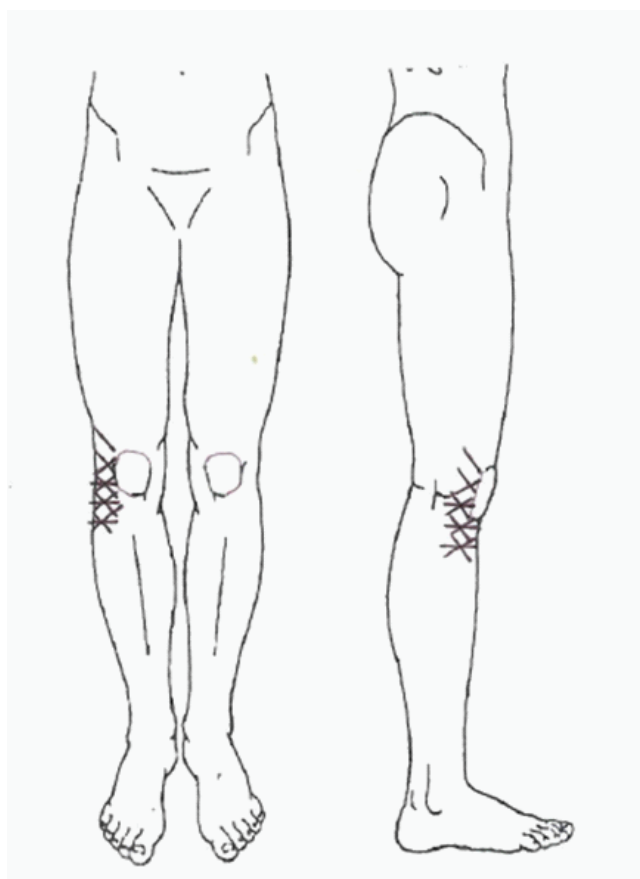


FIGURE 1. Pain diagram.

routine. All four athletes consulted with an orthopedic surgeon, were immobilized or restricted from activity for at least two weeks, had normal MRI results, completed at least six weeks of physical therapy that consisted of therapeutic modalities and strengthening exercises, and were unable to train for more than seven months.

Assessment

Each patient filled out a Lower Extremity Functional Scale (LEFS)⁽²⁷⁾, Global Rating of Change Scale (GRCS)⁽²⁸⁾ (Table 1), and underwent a standardized physical exam. Consent was obtained from each patient to use their information in a case report. The LEFS is a questionnaire containing 20 questions about a person's ability to perform everyday tasks. The tasks are ranked on a scale from zero (extremely difficult or unable to perform) to four (no difficulty performing the activity). The maximum score is 80; the lower the score, the greater the disability. The minimal clinically important difference is 9 scale points⁽²⁷⁾. The reliability of the LEFS was found to be excellent .94 and the validity supported by comparison with the SF-36 physical function subscale ($r = .80$) and the SF-36 physical component score ($r = .64$)⁽²⁷⁾. The GRCS provides a means of measuring self-perceived change in health status⁽²⁸⁾. The main purpose of the GRCS is to quantify the degree to which the patient has improved or deteriorated over time. GRCS involves a single question that asks the patient to rate their change with respect to their condition. The question used in this case series was: "With respect to your knee pain, how would you compare yourself now compared to when you first came in for treatment?" In this study, a 15-point scale, ranging from -7 (a very great deal worse), through 0 (unchanged) to +7 (a very great deal better) was utilized. The minimal clinically important difference is 5 scale points⁽²⁸⁾. The reliability of the GRCS was found to be .90 in a

TABLE 1. Baseline and Post Intervention Scores

	Case 1		Case 2		Case 3		Case 4	
	Baseline	4wks	Baseline	4wks	Baseline	4wks	Baseline	4wks
Lower Extremity Functional Scale	58	77	59	74	65	74	49	52
Global Rating of Change	1	6	3	6	2	7	0	0
Knee Ext Angle								
Right	30°	10°	24°	7°	22°	0°	16°	15°
Left	8°	5°	16°	15°	0°	0°	5°	7°
Ober's Test								
Right	10°	-10°	12°	-18°	5°	-22°	-14°	-20°
Left	-13°	-15°	-20°	-17°	-19°	-20°	-20°	-22°
Running Distance/Miles	.32	3	.55	3	1.23	3	24	.3
Numeric Pain Scale	9	1	9	0	7	0	9	9

cohort of subjects with low back pain⁽²⁸⁾. The GRCS has shown good validity when compared to the Roland Morris disability questionnaire ($r = .50$), Oswestry low back pain disability questionnaire ($r = .78$), and the numeric pain rating scale ($r = .49$)⁽²⁸⁾. The physical exam consisted of bilateral active and passive knee ROM, Valgus and Varus Stress Tests, Lachman's Test, Posterior Drawer Test, Apley's Compression Test, Patellar Grind Test, Knee Extension Angle (KEA)^(29,30) to measure hamstring flexibility, and the Ober's test⁽³¹⁾ to measure iliotibial band flexibility. Patients were also observed while squatting and jumping to identify the presence of dynamic valgus.

The KEA and the Ober's tests were measured with a bubble inclinometer (Table 1). The KEA was performed as described by Gajdosik^(30,32) (Figure 2). The patient was positioned supine on the exam table with one mobilization belt placed across the anterior superior iliac spines and another across the mid-thigh of the left lower extremity. The patient was asked to bring her right thigh toward her chest and support it with both hands clasped behind the knee. The examiner placed a level along the patient's anterior thigh to ensure that the leg was perpendicular to the table. (In the study performed by Gajdosik, a wooden dowel was used to block the subject's thigh to keep the leg perpendicular to the table). A bubble inclinometer was placed on the patient's shin and she was asked to actively straighten her lower leg. The measurement was taken at the end of the range of active knee extension, which is the degree of knee flexion from terminal knee extension. The intratester reliability of the KEA test has been reported to be .99^(30,32,33). A KEA angle of 20° has been defined as a cutoff score indicating hamstring muscle tightness⁽³⁴⁾. Therefore, a KEA angle of greater than 20° indicates hamstring tightness; three of the four athletes exceeded the threshold for hamstring tightness.



FIGURE 2. Measuring knee extension angle (KEA).

The Ober's test was performed (Figure 3), as described by Reese and Bandy⁽³¹⁾. The patient was positioned on the examination table on her left side with the hip and knee of the left lower extremity flexed to 45° and 90°, respectively, in order to stabilize the pelvis. The examiner stood behind the patient and with his left hand stabilized the patient's pelvis. With his right hand the examiner reached under the patient's lower leg and grasped the thigh just above the knee, supporting the lower leg with his forearm. The examiner then passively abducted and extended the hip in line with the trunk. The examiner asked the patient to relax all muscles of the lower extremity, while allowing the uppermost limb to drop toward the table through the available hip adduction range of motion. The end position of hip adduction was defined as the point at which lateral tilting of the pelvis was palpated or when the hip adduction movement stopped, or both. In this position, the examiner maintained the alignment and ensured that no tilting of the pelvis nor internal rotation and flexion of the hip occurred, while a second examiner placed the bubble inclinometer over the lateral epicondyle. If the leg was below horizontal it was recorded as a negative number and if it was above horizontal it was recorded as a positive number. Reese and Bandy⁽³¹⁾ found the Ober's test to have excellent reliability with an ICC value of .90.

After the physical exam was completed, each athlete ran on a treadmill, 0% grade, at her normal running speed until she experienced knee pain sufficient to make her stop running. She was then asked to rate her pain on a numeric scale (NPS) of zero to ten (zero representing no pain and ten representing unbearable pain) just before she stopped running (Table 1). The athletes each filled out a pain diagram illustrating exactly where they were experiencing the pain.



FIGURE 3. Ober's test.

Intervention

The patients were treated by a licensed physical therapist, certified in manual therapy, with over ten years of clinical experience. They were treated three times a week for three weeks and the sessions lasted approximately 40 minutes. They received soft tissue mobilization **only** and were not given any exercises. The patients were instructed to abstain from all physical activity.

During treatment, the patient was positioned supine on the treatment table, head supported by a pillow, right hip and knee flexed. The author stood on the right side of the patient; his right hand stabilized the patient's right leg at the knee joint. The anterior border of the iliotibial band (ITB) was addressed first. The thumb and index finger of the author's left hand contacted the groove between the ITB and the quadriceps distally. The stroke followed the border of the ITB proximally until the greater trochanter was reached (Figure 4). This technique was repeated for 5 minutes.

Next the posterior border of the ITB was mobilized. The author stood facing the foot of the table; his left hand stabilized the patient's right leg at the knee joint. The author's thumb and index finger of his right hand contacted the groove between the ITB and the distal hamstring. The stroke followed the border of the ITB and the hamstring proximally. This technique was repeated for 5 minutes.

The patient remained supine while muscle bending⁽²⁰⁾ of the vastus lateralis was performed (Figure 5). The author's right hand grasped the proximal tibia and knee joint. The left-hand palm was placed over the vastus lateralis. Firmly grasping the proximal



FIGURE 4. Stroking the anterior border of the ITB.

aspect of the tibia with the right hand, the author's left hand sheared the vastus lateralis from lateral to medial over the femur. The force was applied through the palm of the hand. This was repeated along the entire extent of the muscle for 10 minutes.

Two techniques were used to mobilize the biceps femoris. The patient remained supine with the hip and knee flexed approximately 90° and resting over the author's shoulder. The author was seated on the treatment table facing the patient. Contact with the patient was made with the fist at the distal end of the hamstring. The biceps femoris was stroked longitudinally, distal to proximal, for 5 minutes. The patient was then asked to lie prone and muscle bending⁽²⁰⁾ of the biceps femoris and gastrocnemius was performed, as described for the vastus lateralis, for 10 minutes.

At the end of the treatment the patient was asked to lie supine on the treatment table. The hip and knee were passively flexed and extended for 5 minutes.

Reassessment

The patients were reassessed after four weeks (Figure 6). The reassessment included filling out a Lower Extremity Functional Scale (LEFS) and the Global Rating of Change Scale (GRCS), remeasuring hamstring and iliotibial band flexibility, and determining running tolerance on the treadmill. The patients were called on the telephone at eight weeks and asked their Global Rating of Change (Figure 6).

RESULTS

At four weeks, three of the athletes were able to run on the treadmill, 0% grade, at their running speed, for three miles without having to stop due to lateral knee pain. All three athletes stated that they could continue past three miles; however, the test was stopped due



FIGURE 5. Muscle bending the vastus lateralis.

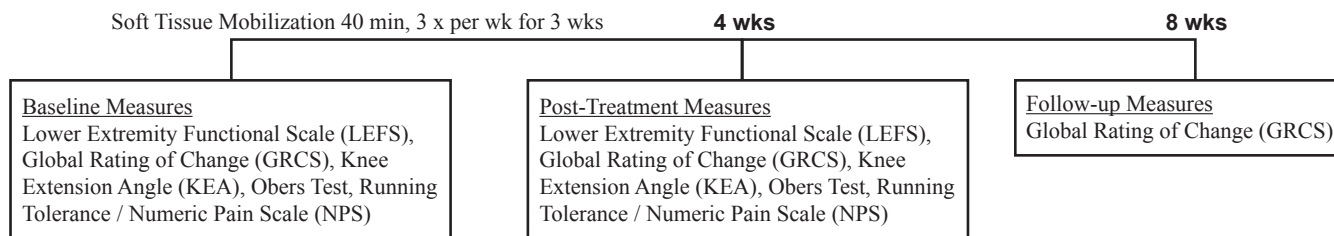


FIGURE 6. Protocol timeline.

to time constraints. Two athletes rated their pain zero on a 10-point scale, and one athlete rated her pain one on a 10-point scale. One of the athletes experienced lateral knee pain after running 0.3 miles, which she rated a 9/10, and had to stop.

The three athletes who were able to run without pain improved 9 to 19 points on the Lower Extremity Functional Scale, 3 to 5 points on the Global Rating of Change Scale, and they all demonstrated improvement in hamstring and ITB flexibility (Table 1). The athlete who was unable to run on the treadmill improved 3 points on the Lower Extremity Functional Scale and 0 points on the Global Rating of Change Scale, and demonstrated some improvement in hamstring and ITB flexibility (Table 1).

At eight weeks, the Global Rating of Change for three athletes was a 7 (“a very great deal better”) and they had returned to training with no complaints of lateral knee pain (Table 2). One athlete underwent arthroscopic surgery and had her lateral meniscus debrided. She was receiving physical therapy and doing well.

DISCUSSION & CONCLUSION

Lateral knee pain encountered by triathletes is frequently caused by repetitive stress to the musculo-tendinous structures that surround the knee. The onset is usually precipitated by a change in training routine that exceeds the tissues ability to adapt. Our four athletes started running hills, took a longer bike ride than usual, increased running mileage too quickly, and rode a new bike that was not fit properly. When they were seen by a physician, they were either immobilized with a brace and/or restricted from activity.

TABLE 2. Global Rating of Change Scores at Baseline, 4 Wks, and 8 Wks

	Case 1	Case 2	Case 3	Case 4
Baseline	1	3	2	0
4wks	6	6	7	0
8wks	7	7	7	a

^aSubject underwent arthroscopic surgery to debride a lateral meniscus tear.

Histological studies on the effects of immobilization of connective tissue have demonstrated loss of ground substance and water, formation of collagen interfiber cross links, haphazard lying down of newly synthesized collagen, and microadhesions formed from scar tissue that adheres to adjacent nontraumatized connective tissue^(35,36,37,38,39). These physiological changes may result in restricted tissue mobility, altered neurodynamics, limited joint ROM, and ultimately influence function.

Management of an acute sports injury should include intermittent range of motion to maintain tissue mobility. If a joint must be immobilized, the brace should allow for some motion to occur, or be intermittently removed for active and passive range-of-motion exercises⁽⁴⁰⁾. When an athlete is restricted from normal activity and told to “rest”, he or she should also be instructed to perform daily exercises that take the joint through a full range of motion.

The goal of soft tissue mobilization is to rehydrate connective tissue, stimulate the production of ground substance, assist in orienting of collagen fibers, and break microadhesions^(40,20,3). The result is improved soft tissue mobility, reduced stress on pain sensitive structures, and better function. This author has treated many athletes with lateral knee pain using soft tissue mobilization. Success of treatment is dependent on an accurate diagnosis, ruling out other common causes for lateral knee pain such as lateral meniscus tear, lateral collateral ligament sprain, patellofemoral dysfunction, osteochondral injury, biceps femoris tendonitis, iliotibial band friction syndrome or osteoarthritis. The techniques themselves are not difficult; however, determining the cause of the lateral knee pain can be challenging. In this case series one athlete had an intra-articular dysfunction that did not respond to soft tissue mobilization. She ended up having arthroscopic surgery to debride her lateral meniscus. At seven weeks postsurgery she was able to run without pain and returned to triathlon training.

After ruling out common causes for lateral knee pain, soft tissue restriction should be considered a potential source of dysfunction. In some cases, soft tissue restriction is overlooked; athletes go undiagnosed and are limited from sports participation. Further studies on the effectiveness of treating lateral knee pain with soft tissue mobilization should be conducted with a larger number of subjects, blinded

evaluators, and a randomized control. The subjects could include athletes from different sports with unresolved lateral knee pain.

CONFLICT OF INTEREST NOTIFICATION

The author declares there are no conflicts of interest.

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REFERENCES

- Gosling C, Gabbe B, Forbes A. Triathlon related musculoskeletal injuries: the status of injury prevention knowledge. *J Sci Med Sport*. 2008;11(4):396–406.
- Anderson C, Clarsen B, Johansen T, Engebresten L. High prevalence of overuse injury among iron-distance triathletes. *Br J Sports Med*. 2013;47:857–861.
- Clements K, Yates B, Curran M. The prevalence of chronic knee injury in triathletes. *Br J Sports Med*. 1999;33(3):214–216.
- Vleck V, Bentley D, Millet G, Cochrane T. Triathlon event distance specialization: training and injury effects. *J Strength Cond Res*. 2010;24(1):30–36.
- Michael M, Erikson K, Morris H, Young D. MRI-negative bucket-handle tears of the lateral meniscus in athletes: a case series. *Knee Surg Sports Traumatol Arthrosc*. 2006;14:1012–1016.
- Safran M. Uncommon causes of knee pain in the athlete. *Orthop Clin N Am*. 1995;26(3):547–559.
- Wilson W, Deakin A, Payne A, Picard F, Wearing S. Comparative analysis of the structural properties of the collateral ligaments of the knee. *J Orthop Sports Phys Ther*. 2012;42(4):345–351.
- Fulkerson J, Arendt E. The female knee: anterior knee pain. *Conn Med*. 1999;63(11):661–664.
- Rixie J, Glick J, Brady J. A review of the management of patellofemoral pain syndrome. *Phys Sportsmed*. 2013;41(3):19–28.
- Tyler T, Long J. Rehabilitation following osteochondral injury to the knee. *Curr Rev Musculoskeletal Med*. 2012;5(1):72–81.
- Ahmad C, Redler L, Cicotti M, Maffulli N, Lungo V, Bradley J. Evaluation and management of hamstring injuries. *Am J Sports Med*. 2013;41(12):2933–2947.
- Barber A, Sutker A. Iliotibial band syndrome. *Sports Med*. 1992;14(2):144–148.
- Holmes J, Pruit A, Whalen N. Lower extremity overuse in bicycling. *Clin Sports Med*. 1994;13(1):187–205.
- Straus E, Kin S, Callej J, Park D. Iliotibial band syndrome evaluation and management. *J Am Acad Ortho Surg*. 2011;19(12):728–736.
- Cicuttini F, Baker J, Hart D, Spector T. Association of pain with radiological changes in different compartments and views of the knee joint. *Osteoarthritis Cartil*. 1996;4(2):143–147.
- Ferguson L. Knee pain: addressing the interrelationships between muscle and joint dysfunction in the hip and pelvis and lower extremity. *J Bodywork Move Ther*. 2006;10(4):287–296.
- Bozkurt M, Can F, Erden Z, Demirkale I. The influence of lateral tightness on lateral knee pain. *The Pain Clinic*. 2004;16(3):343–348.
- Hartig D, Henderson J. Increasing hamstring flexibility decreases lower extremity overuse injuries in military basic trainees. *Am J Sports Med*. 1999;27(2):173–176.
- Strock G, Cottell E, Lohman J. Triathlon. *Phys Med Rehab Clin N Am*. 2006;17(3):553–564.
- Cantu R, Grodin A. *Myofascial Manipulation: Theory and Clinical Application*, 2nd edition. Gaithersburg, MD: Aspen Publishers; 2001.
- Cooper G. Some clinical considerations on fascia in diagnosis and treatment. *J Am Osteopath Assoc*. 1979;78(5):336–347.
- Findley T. Fascia research II. Second international fascia research congress. *Int J Ther Massage Bodywork*. 2009;2(3):4–9.
- Nee R, Butler D. Management of peripheral neuropathic pain: integrating neurobiology, neurodynamics, and clinical evidence. *Phys Ther Sport*. 2006;7(1):36–49.
- Rolf I. *Rolfing: the Integration of Human Structures*. New York, NY: Harper and Row; 1977.
- Fitzpatrick M. Triathlon injuries: the swim-bike-run how-to for medical practitioners. *Aust Fam Phys*. 1991;20(7):953–958.
- Cook S, Kester M, Brunet M, Hadden R. Biomechanics of running shoe performance. *Clin Sports Med*. 1985;4(4):619–626.
- Blinkley J, Stratford P, Lotts S, Riddle D. The lower extremity functional scale (LEFS): scale development, measurement properties, and clinical application. *Phys Ther*. 1999;7(4):371–383.
- Kamper S, Maher C, Mackay G. Global rating of change scale: a review of strengths and weaknesses and considerations for design. *J Man Manip Ther*. 2009;17(3):163–170.
- Davis S, Quinn R, Whiteman C, Williams D, Young C. Concurrent validity of four clinical tests used to measure hamstring flexibility. *J Strength Cond Res*. 2008;22(2):583–588.
- Gajdosik R, Lusin G. Hamstring muscle tightness: reliability of an active-knee-extension test. *Phys Ther*. 1983;63(7):1085–1088.
- Reese N, Bandy W. Use of an inclinometer to measure flexibility of the iliotibial band using the Obers Test and the Modified Obers Test: differences in magnitude and reliability of measurements. *J Ortho Sports Phys Ther*. 2003;33(6):303–362.
- Gajdosik R, Rieck M, Sullivan D, Wightman S. Comparison of four clinical tests for assessing hamstring muscle length. *J Ortho Sports Phys Ther*. 1993;18(5):579–633.
- Sullivan M, DeJulia J, Worrell T. Effect of pelvic position and stretching method on hamstring muscle flexibility. *Med Sci Sport Exerc*. 1992;24(12):1383–1389.
- Davis D, Ashby P, McCale K, McQuain J, Wine J. The effectiveness of three stretching techniques on hamstring flexibility. *J Strength Cond Res*. 2005;19(1):27–32.
- Akenson W, Woo S, Amiel D, Coutts R, Daniel D. The connective tissue response to immobility: biomechanical changes in periarticular connective tissue of the immobilized rabbit knee. *Clin Orthop Relat Res*. 1973;93:356–362.
- Barlow Y, Willoughby J. Pathophysiology of soft tissue repair. *Br Med Bull*. 1992;48(3):698–711.
- Donatelli R, Owens-Burkhart H. Effects of immobilization on the extensibility of periarticular connective tissue. *J Ortho Sports Phys Ther*. 1981;3(2):67–72.

38. Van Der Meulen J. Present state of knowledge on processes of healing in collagen structures. *Int J Sports Med.* 1982;3 (Suppl 1):4–8.
39. Woo S, Mathews J, Akeson W, Amiel D, Covery R. Connective tissue response to immobility. Correlative study of biomechanical and biochemical measurements of normal and immobilized rabbit knees. *Arthritis Rheum.* 1975;18(3):257–264.
40. Arem A, Madden J. Effects of stress on healing wounds: 1. Intermittent noncyclical tension. *J Surg Res.* 1976;20(2):93–102.

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