Published in final edited form as:
Int Musculoskelet Med. 2009 December 1; 31(4): 159–165. doi:10.1179/175361409X12472218840924.

Repair of a complete anterior cruciate tear using prolotherapy: a case report

Walter Grote, DO,
Sparta Medical Associates, Columbia NJ, 07832

Rosa Delucia,
University of Wisconsin Department of Family Medicine, 777 S. Mills St, Madison WI, 53715

Robert Waxman, MD,
Diagnostic Radiology Associates, PA, Clifton, NJ 07013

Aleksandra Zgierska, MD, PhD,
University of Wisconsin Department of Family Medicine, 777 S. Mills St, Madison WI, 53715

John Wilson, MD, and
University of Wisconsin Department of Family Medicine, 777 S. Mills St, Madison WI, 53715

David Rabago, MD
University of Wisconsin Department of Family Medicine, 777 S. Mills St, Madison WI, 53715

Abstract

Objective and Importance—Surgical reconstruction is considered definitive treatment for anterior cruciate ligament (ACL) tears but precise surgical indications are debated. Some patients are reluctant or inappropriate surgical candidates. Prolotherapy is a non-surgical injection therapy for chronic musculoskeletal pain and instability. This case report documents the non-surgical repair of a torn ACL using prolotherapy and at-home exercise.

Clinical Presentation and Intervention—The 18 year old female patient sustained a right knee injury during a downhill skiing accident. Magnetic Resonance Imaging (MRI) revealed a high-grade partial versus complete rupture; Lachman exam findings suggested a complete rupture. She deferred surgical treatment. At 21 weeks post-injury, with unstable gait, inability to climb stairs and more than 1 cm anterior drawer test, she consented to undergo prolotherapy injections. She received 7 prolotherapy sessions over a 15 week period. At-home exercises were initiated at the 3rd prolotherapy session.

Results—The patient improved. Walking on flat ground improved 4 weeks after initiation of prolotherapy; she could ride a stationary bicycle for 30 minutes by 12 weeks. By 15 weeks, the patient had no instability climbing and descending stairs, the anterior drawer test was negative and MRI showed an intact ACL with fibrosis. Subsequently, she returned to full sport activity.

Conclusions—We document the non-surgical repair of a high-grade partial or complete ACL tear using prolotherapy and at-home exercise. Prolotherapy may be an alternative to surgery in carefully selected patients. This report is consistent with findings of recent pilot-level studies and suggests the need for rigorous clinical trials assessing prolotherapy as treatment for ligament and tendon injury in selected patients.

Corresponding Author: David Rabago, MD, University of Wisconsin Department of Family Medicine, 777 S. Mills St, Madison WI, 53715, David.rabago@fammed.wisc.edu, Ph 608-265-2487, Fx 608-263-5813.

Keywords

anterior cruciate ligament; prolotherapy; sclerotherapy; dextrose; morrhuate sodium

Introduction

The anterior cruciate ligament (ACL) is essential for normal knee function.[1] Trauma to the ACL can occur during contact and high-impact sports, but is most commonly sustained in non-contact situations, as when an athlete decelerates, pivots/turns quickly, or lands hard from a jump.[2] Females are particularly vulnerable to ACL injuries due to anatomical, biomechanical, neuromuscular and hormonal differences.[3] Optimal surgical and medical management of ACL injuries is unclear [4] and vigorously debated.[5] Treatment of ACL tears in the developed world is often surgical. However, surgical reconstruction may alter the normal anatomy and have deleterious effects on the native knee and articular cartilage.[6] Post-operative rehabilitation requires 6–12 months, or more to return to competitive sports. In 2000, about 175,000 ACL reconstructions were performed in the US at a cost of more than $2 billion.[7] ACL tears may lead to meniscal injuries and failure of secondary knee stabilizers and the early onset of osteoarthritis in the knee.[8] Although operative ACL reconstruction decreases risk of secondary meniscal tears, it has not been shown to decrease risk of degenerative joint disease. These high patient and societal costs have prompted investigation of non-operative treatment methods in certain individuals.

This case report documents the non-surgical repair of an magnetic resonance (MRI)-proven ACL tear using prolotherapy, a technique involving multiple injections into and around the injured tissue using one or more injectants,[9] and adjunctive at-home exercise. Prolotherapy solutions are believed to initiate a local healing response in chronic soft tissue injuries, though the precise mechanism of action is not known. Prolotherapy has also been termed 'sclerotherapy' and regeneration injection therapy'.[10, 11] It has traditionally been used for a variety of musculoskeletal conditions since 1937,[12, 13] most commonly low back pain, for which randomized controlled trials (RCTs) have reported equivocal results.[13] More robust effects of prolotherapy have been reported for tendinopathy.[14–16] At least one case study reports positive prolotherapy outcomes in ligament rupture.[17] The use of prolotherapy is common and growing.

Patient and Methods

Case Report

An 18 year-old physically fit Chinese-American female sustained a right knee injury while downhill skiing in the US. She was seen urgently in a local emergency department where an orthopedic surgeon informed her that, based on clinical findings, she likely had a complete ACL tear. She was treated with a knee brace and given conservative instructions. She returned to her home town and, at 2 weeks post-injury, saw a second orthopedic surgeon who confirmed the findings of ACL tear via physical exam and MRI, and advised her to have surgery.

The MRI was performed on a Philips Gyroscan 1.5 Tesla device using multiple imaging sequences in multiple projections. Pre- and post-treatment MRI were initially interpreted by a radiologist and later over-read by a fellowship trained Sports Medicine physician (JW) as part of the write-up of this case. (Table 1). Initial sagittal fat-saturated T2, sagittal non-fat saturated proton density and axial fat-saturated T2 images revealed a heterogeneous ACL, lax proximal to the midsubstance. No intact fibers were seen; the ACL injury was described as an "extensive high-grade partial tear or complete tear" There was a minimal radiological anterior drawer sign. Associated corresponding subchondral bone contusions were present at the posterolateral

tibial plateau. There was mild perifascial and myofascial edema at the popliteus musculotendinous complex and lateral popliteal fossa, suggesting capsular injury (Figure 1a–f)

The patient declined surgical treatment. Due to ongoing right knee symptoms, she was then assessed, at 18 weeks post-injury, in a musculoskeletal medicine clinic by the lead author (WG). At that time, although she did not report a significant resting knee pain, the knee dysfunction did not allow her to perform normal activities of daily living, and buckled frequently with weight-bearing. She reported ambulating poorly without crutches and not being able to walk up or down stairs without support. Physical exam revealed more than 1 cm of laxity on the right anterior drawer test compared to minimal laxity on the left, and a significantly positive Lachman's test, consistent with a complete ACL tear with soft or no endpoint.

Past medical and surgical histories were non-contributory.

Ethics

The patient and her family were informed by the treating physician (WG) that the patient's signs and symptoms, along with the results of MRI, suggested a complete ACL tear, and that surgical reconstruction is the conventional treatment given the severity and clinical context of injury. The patient, with her family's approval, desired that less invasive treatments be fully explored prior to surgical consult. The patient was fully informed about, and gave consent for a trial of prolotherapy and at-home exercise as treatment for her ACL injury.

Injection and Exercise Therapy

The patient received 7 prolotherapy treatment sessions using a tailored set of injectants over 15 weeks at 1–4 week intervals. The solution type (Table 2) and injection sequence (Table 3) were based on the treating physician's personal experience with these agents in the context of ligamentous injury.

The injection sites were chosen based on MRI and palpatory exam findings using published prolotherapy injection guidelines.[9] Radiological guidance was not used for injections. During each prolotherapy session the knee joint, the ACL and posterior cruciate ligament (PCL) were injected via an anterior approach (the medial paramedian window) using a 3.5 or 5 mL Luer-lock syringe with a 25 gauge 2-inch needle. Up to six sites on both ACL and PCL were injected in a peppering fashion, using 0.2–0.4 mL solution per both ACL and PCL, and the remainder of solution was injected in the knee joint (Figure 2). During injection sessions 4 and 5, the patient noted increased activity with her right knee and associated new areas of knee pain. In response to this concern and findings of areas with new tenderness to palpation, the following extra-articular structures were injected: anterior capsule, medial and lateral patellar retinaculi, and medial and lateral collateral ligaments. Finally, an intra-articular injection of 0.5mL of the solution used during a particular session was injected into the joint space at the end of each session. A total of 3.5–5.5 mL of solution were used per injection session. Local anesthesia (1–3 mL of either lidocaine or bupivacaine) was used prior to injection during all but the 6th prolotherapy session.

After the third injection session (27 weeks post-injury), the first physical therapy (progressive home exercises) were prescribed. They consisted of leg extensions (3 sets of 8 repetitions, up to 10 times daily) and 1/3 squats (30–60 degree, 8 repetitions, up to 3 times daily). The patient was instructed to begin light use of an exercise bicycle.

Treatment Results

With the exception of treatment sessions 4 and 5, at which times pain may have been associated with increased activity, the patient reported generally diminished symptoms and improved function over the course of the injection sessions.

At 32 weeks post-injury (12 weeks after initiation of prolotherapy), the patient's function was much improved; she was able to walk, and climb and descend stairs independently without instability. She felt increased knee strength, and reported being back to 80% of baseline. She was able to perform 3 sets of 8 repetitions of leg extensions with 7 lb-weights, and started biking 30 minutes per day.

At 37 weeks post-injury (15 weeks after initiation of prolotherapy), her anterior drawer test was normal and symmetrical to that of the left knee. She returned to independent ambulation, bicycling and jogging, and was very satisfied with her care. Her post-treatment MRI showed a well-healed, relatively homogeneous ACL. Only minimal irregularity and heterogeneity were seen in the midportion of ACL at the location of prior injury. No anterior drawer sign or bone contusion were noted. The MRI was interpreted as compatible with a healing, chronic near-complete or complete ACL tear.

Discussion

This case report documents the successful non-surgical repair of an MRI-confirmed high grade or total ACL tear in an 18 year old female with knee laxity and instability using prolotherapy and at-home exercise. After treatment, the patient regained full knee function, resumed normal activity and returned to recreational sport. Post-treatment MRI revealed a healing chronic ACL tear. These findings are notable given that surgical ACL reconstruction is the conventional treatment for ACL tears with such clinical presentation.

This case is consistent with another published case reporting the repair of a completely ruptured Achilles tendon[17] using prolotherapy. In this report, a 26 year old female athlete with an MRI- and ultrasound-documented Achilles tendon rupture experienced excellent clinical improvement with a 14-week course of 8 prolotherapy sessions using dextrose and morrhuate sodium and at-home isometric exercises. The author reported that post-treatment MRI and ultrasound revealed an intact, slightly atrophic, chronically injured Achilles tendon. A subsequent letter to the editor regarding this case, however, contended that the images provided did not support the description of the injured state of the tendon, casting doubt on the modification of inured tissue by prolotherapy reported by the author. Reeves et al. have also reported positive effects of prolotherapy on injured ACLs. [18] Subjects with knee osteoarthritis, and knee pain with ACL laxity were found to have slightly decreased laxity 12 months after prolotherapy. However, no subjects had significant ACL injury, limiting comparison to the current report.

While no rigorous clinical trials have assessed prolotherapy as a treatment for ligamentous tears, 4 recent studies of prolotherapy for severe overuse tendinopathies[14–16] have reported positive findings. Subjects with severe lateral epicondylosis treated with morrhuate sodium and dextrose prolotherapy experienced 68% pain reduction and improved isometric strength compared to control saline injections ($p<0.05$) at 16 weeks post-treatment.[15] Subjects with chronic symptomatic Achilles tendinopathy have been evaluated in a strong pilot level RCT and prospective case series. In Yelland et al.,[19] 40 subjects with painful mid-portion Achilles tendinosis received eccentric exercise, prolotherapy injections, or combined treatment. Combined treatment resulted in significantly better clinical and financial outcomes. In Maxwell et al., subjects received ultrasound-guided dextrose prolotherapy and, at 6 weeks post-treatment, reported a reduction of pain by 80–90% during rest, light activity and sports, and

showed improved ultrasound findings.[14] Elite male athletes with chronic adductor groin pain and inability to play soccer or rugby received dextrose prolotherapy and reported a 78% improvement in pain with activity; 83% of these subjects reported a complete resolution of pain and 92% were able to return to unrestricted sport activity.[16]

The mechanism by which prolotherapy may influence soft tissue healing is not known. Connective tissue often heals poorly due to limited vascular supply. Prolotherapy is hypothesized to stimulate an auto-regulatory immune response leading to the reestablishment of structural integrity, improved function and pain relief.[9] Animal model studies have reported significant biological effects for prolotherapy injections with both dextrose (an irritant)[20] and morrhuate sodium (a vascular sclerosant).[21, 22, 23] Pumice suspension and phenol-quinine-urea solution have not been rigorously evaluated in animal or human studies, though they are in limited use in the prolotherapy community. Both are thought to be irritants; pumice is hypothesized to attract macrophages, while phenol-quinine-urea is hypothesized to directly alkylate proteins on the surfaces of cells. In either case, granulocytes and macrophages are attracted to the injection site and the wound healing cascade is initiated.[24] Prolotherapy is one of several injection therapies that may initiate a regenerative response in chronically injured soft tissue. A recent systematic review suggested that injections with polidocanol, whole blood and platelet rich plasma may each also confer this effect compared to control injections.[25]

While prolotherapy may have played a role in this patient's clinical recovery and the improvement in the appearance of her MRI, several caveats prevent the conclusion that prolotherapy alone was responsible. 1) While MRI is the diagnostic imaging technique of choice, it is not perfect. A recent systematic review reported it's overall sensitivity and specificity for ACL injury to be 86.5% and 95.2% respectively.[26] The tear may have therefore have been near-complete, or the severed ends of the ligament may have been in close enough approximation to facilitate natural healing. On the other hand, the presence of subchondral bone contusions have been reported to be significantly more associated with complete ACL ruptures than with incomplete tears.[27] 2) The Lachman test also is not perfect. Overall sensitivity and specificity for ACL tear have been reported to be 86% and 91% respectively, [28] though two other examiners in this case (at initial accident and in Orthopedic consultation) concurred on the likelihood of at least a high-grade tear. In addition, parts of the clinical exam, including knee buckling are consistent with other conditions such as patellofemoral knee pain. 3)The post-treatment ligament is not completely normal; the degree of fibrosis might conceivably be found on an untreated ACL in response to time and physiotherapy. Other limitations include the lack of an early supervised ACL rehabilitation program and the lack of independent confirmation of physical exam results.

This case report is strengthened by description of the pragmatic use of prolotherapy by a physician specializing in musculoskeletal medicine and experienced in injection medicine who tailored therapy specifically to this patient and her clinical progress over time. Prior clinical trials have used fixed solution recipes and injection schedules which do not allow responsiveness to individual clinical change. The components of the solutions injected and timing of injections used in this case reflect a common practice pattern within the clinical prolotherapy community; solutions used early in a treatment course (dextrose, morrhuate sodium) are perceived to be less 'strong' than those used later in the treatment course (phenol-quinine-urea, pumice). However, the complexity of the regimen limits its incorporation into routine practice. The relative effectiveness of prolotherapy solutions compared to one another has not been compared in any clinical trial.

The limitations above prevent a categorical conclusion that prolotherapy alone contributed to or restored pain-free function and improved the appearance of the MRI. However, the facts of this case and the context provided by prior clinical trials suggest that prolotherapy at least

augmented the healing a high grade or total ACL tear. These findings further suggest that prolotherapy may be an alternative treatment to surgery for carefully selected patients and should be assessed as a treatment of ligamentous tears, especially in patients who are unwilling or unable to undergo surgical intervention.

Conclusions

This report documents for the first time the non-surgical repair of a torn ACL using prolotherapy and at-home exercise. This case suggests that prolotherapy and at-home exercise may be an alternative treatment to surgery in carefully selected patients, and may have disease-modifying properties at the tissue level as seen on MRI. The study adds to recent pilot-level literature suggesting that more formal studies assessing prolotherapy as a treatment for ligamentous tears are warranted.

Acknowledgments

Jessica Grettie

References

1. Johnson RJ, Beynnon BD, Nichols CE, Renstrom PA. The treatment of injuries of the anterior cruciate ligament. J Bone Joint Surg Am 1992;74:140–151. [PubMed: 1734005]
2. Griffen L, Agel J, Albohm MJ, Arendt EA, Dick RW, Garrett WE, et al. Noncontact ACL injuries: risk factors and prevention strategies. J Am Acad Orthop Surg 2000;8:141–150. [PubMed: 10874221]
3. Shuterback S. The incidence of ACL tears in men and women collegiate soccer players. Ortho Trans 1996;20:259.
4. Engstrom B, Gornitzka J, Johansson C, Wredmarkl T. Knee function after anterior cruciate ligament ruptures treated conservatively. Int Orthop 1993;17:208–213. [PubMed: 8407034]
5. Johnson DH, Maffulli N, King JB, Shelbourne KD. Anterior Cruciate Ligament Reconstruction: A Cynical View From the British Isles on the Indications for Surgery. Arthroscopy: The Journal of Arthroscopic and Related Surgery 2003;19:203–209.
6. Moore, KL. Essential Clinical Anatomy. 3. Lippincott, Williams, & Wilkins; USA: 2006.
7. Spindler KP, Wright RW. Anterior Cruciate Ligament Tear. NEJM 2008;359:2135–2142. [PubMed: 19005197]
8. Beynnon BD, Johnson RJ, Abate JA, Fleming BC, Nichols CE. Treatment of Anterior Cruciate Ligament Injuries, Part I. Am J Sports Med 2005;33:1579–1602. [PubMed: 16199611]
9. Hackett, GS.; Hemwall, GA.; Montgomery, GA. Ligament and tendon relaxation treated by prolotherapy. 5. Oak Park: Gustav A. Hemwall; 1993.
10. Gedney E. The application of sclerotherapy in spondylolisthesis and spondylolysis. The Osteopathic Profession 1954:66–9. 102–105.
11. Linetsky, FS.; Rafael, MF.; Saberski, L. Pain management with regenerative injection therapy (RIT). In: Weiner, RS., editor. Pain Management. Boca Raton: CRC Press; 2002. p. 381-402.
12. Rabago D, Best T, Beamsly M, Patterson J. A systematic review of prolotherapy for chronic musculoskeletal pain. Clinical J Sports Med 2005;15(5):376–380.
13. Dagenais S, Ogunseitan O, Haldeman S, Wooley JR, Newcomb RL. Side effects and adverse events related to intraligamentous injection of sclerosing solutions (prolotherapy) for back and neck pain: a survey of practitioners. Arch Phys Med Rehabil 2006;87:909–913. [PubMed: 16813776]
14. Maxwell NJ, Ryan MB, Taunton JE, Gillies JH, Wong AD. Sonographically guided intratendinous injection of hyperosmolar dextrose to treat chronic tendinosis of the Achilles tendon: a pilot study. Am J Roent 2007;189(4):W215–220.
15. Scarpone M, Rabago D, Zgierska A, Arbogest J, Snell ED. The efficacy of prolotherapy for lateral epicondylosis: a pilot study. Clinical J Sports Med 2008;18:248–254.

16. Topol GA, Reeves KD, Hassanein KM. Efficacy of dextrose prolotherapy in elite male kicking-sport athletes with groin pain. Arch Phys Rehabil 2005;86:697–702.

17. Lazzara MA. The non-surgical repair of a complete Achilles tendon rupture by prolotherapy: biological reconstruction. A case report. J Orthopaedic Med 2005;27:128–132.

18. Reeves KD, Hassanein KM. Long-term effects of dextrose prolotherapy for anterior cruciate ligament therapy. Alternative Therapies in Health and Medicine 2003;9(3):58–62. [PubMed: 12776476]

19. Yelland MJ, Sweeting KR, Lyftogt JA, Ng SK, Scuffham PA. Prolotherapy injections and eccentric loading exercises for painful Achilles tendinosis: a randomised trial. Br J Sports Med. 200910.1136/bjsm.2009.057968

20. Jensen K, Rabago D, Best TM, Patterson JJ, Vanderby R. Early inflammatory response of knee ligaments to prolotherapy in a rat model. J Orthop Res 2008;26:816–823. [PubMed: 18240327]

21. Micromedex. Morrhuate sodium, Drugdex evaluation. Micromedex Healthcare Series; 2009.

22. Liu YK, Tipton CM, Matthes RD, Bedford TG, Maynard JA, Walmer HC. An in-situ study of the influence of a sclerosing solution in rabbit medial collateral ligaments and its junction strength. Connective Tissue Research 1983;11:95–102. [PubMed: 6224646]

23. Aneja A, Spero G, Weinhold P, et al. Suture plication, thermal shrinkage and sclerosing agents. American Journal of Sports Medicine 2005;33:1729–1734. [PubMed: 16093538]

24. Banks A. A rationale for prolotherapy. Journal of Orthopaedic Medicine 1991;13(3):54–59.

25. Rabago D, Best TM, Zgierska A, Zeisig E, Ryan M, Crane D. A systematic review of four injection therapies for lateral epicondylosis: prolotherapy, polidocanol, whole blood and platelet rich plasma. BJSM. 200910.1136/bjsm.2008.052761

26. Crawford R, Walley G, Bridgman S, Maffulli N. Magnetic resonance imaging versus arthroscopy in the diagnosis of knee pathology, concentrating on meniscal lesions and ACL tears: a systematic review. British Medical Bulletin 2007;84:5–23. [PubMed: 17785279]

27. Zeiss J. Comparison of bone contusion seen by MRI in partial and complete tears of the anterior cruciate ligament. J Comput Assist Tomogr 1995;19:773–776. [PubMed: 7560324]

28. Ostrowski JA. Accuracy of 3 diagnostic tests for anterior cruciate ligament tears. J Athl Train 2006;41:120–121. [PubMed: 16619105]

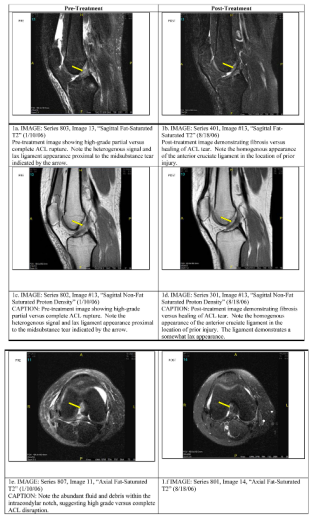

Figure 1.

a–f. Pre- and Post-Treatment Sagittal Fat-Saturated T2, Sagittal Non-Fat Saturated Proton Density and Axial Fat-Saturated T2 MRI Images

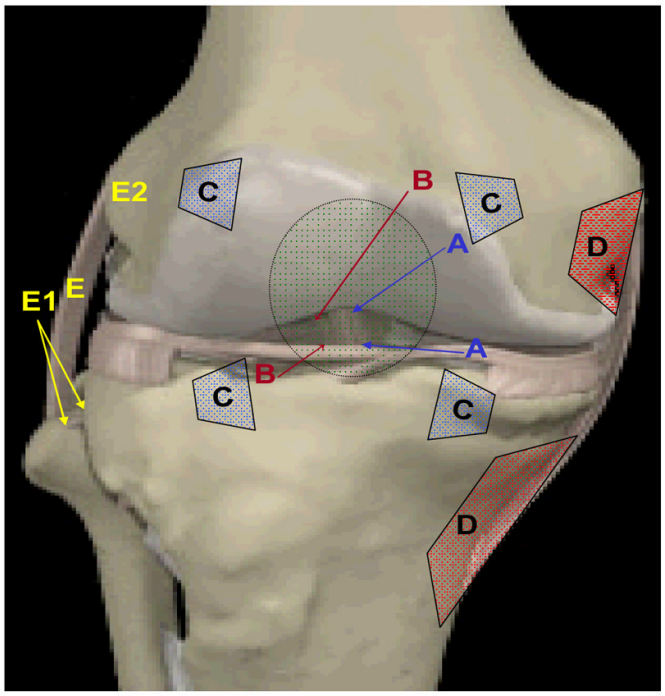

Figure 2.
Injection Locations

Table 1

Formal Impressions of Pre- and Post-treatment Right Knee MRI to Evaluate Presumed ACL Injury

Pre-Treatment	Post-Treatment
At least a high-grade partial anterior cruciate ligament tear or complete tear in the mid substance with associated large bone contusion involving the lateral tibial plateau. No evidence of tibial plateau depression. Moderate-sized joint effusion. Extensive perifascial edema in the popliteal fossa suggesting capsular rupture.	This patient appears to have healed completely. The anterior cruciate ligament is now well demonstrated and shows no evidence for a tear. In addition, bone contusions have resolved.

Table 2

Prolotherapy solution ingredient combinations[1]

Prolotherapy Solutions	Ingredients
1	1 mL 50% dextrose solution and 0.2 mL 5% sodium morrhuate
2	0.5–1.5 mL 50% dextrose solution and 0.2–0.5 mL 5% sodium morrhuate and 0.01–0.1 mL phenol-quinine-urea solution
3	0.1 mL 5% sodium morrhuate and 0.1 mL phenol-quinine-urea solution and 0.3 mL pumice suspension

[1]Solutions of five different prolotherapy agents, listed in the Table, in a variety of concentrations, were used to treat this patient; they are grouped into three core solutions.

Table 3

Prolotherapy Treatments by ingredient and treatment session[1]

Active Ingredient	Week of Treatment						
	0	1	4.5	8	11	13	15
50 % Dextrose (0.5–1.5 mL)	✓	✓	✓	✓	✓		✓
5% Morrhuate Sodium (0.1–0.5 mL)	✓	✓	✓	✓	✓	✓	✓
Phenol-quinine-urea (0.01–0.1 mL)		✓	✓	✓	✓	✓	✓
Pumice suspension (0.3 mL)						✓	

[1]Individual ingredients were used in varying volumes; the range of volumes used is therefore presented.