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Distal Medial Collateral Ligament Grade III Injuries in Collegiate Football Players: Operative Management, Rehabilitation, and Return to Play

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Context: Management of isolated grade III medial collateral ligament injuries is controversial, as both nonoperative and operative management can result in return to play. However, operative management is recommended in elite athletes who have a grade III injury with distal avulsion.

Objective: We present a standardized rehabilitation protocol in a case series of 7 National Collegiate Athletic Association Division I American football athletes who sustained grade III distal medial collateral ligament tears that were repaired operatively, with emphasis on return to play.

Results: Median time to surgery was 4 days (range = 2–67 days). Median time from surgery to noncontact drills was 120.5 days (range = 104–168 days), and median time from surgery to full-contact sport was 181 days (range = 139–204 days). All athletes returned to play at their preinjury level of competition.

Conclusions: Our study highlighted how operative management with a standardized rehabilitation protocol can be applied to Division I football players and result in safe return to play.

Key Words: knee, physical rehabilitation, case series

Key Points

- Athletes with grade III medial collateral ligament distal avulsion injuries can be managed operatively.
- A standardized rehabilitation protocol for medial collateral ligament injuries is important for returning elite athletes to play.

Every year, 300 000 patients visit an emergency department in the United States after sustaining an injury to the knee from sport-related activity.[1] The medial collateral ligament (MCL) is the most commonly injured ligament in the knee and is reportedly torn in almost 8% of all knee injuries.[2] The high propensity for MCL injury relates to the many fibers that compose it, including the posterior oblique ligament, tibial collateral ligament, and multiple meniscofemoral (ligaments of Humphrey and Wrisberg) and meniscotibial (coronary ligament) components.[3,4] The MCL's variable composition has granted it multiple biomechanical roles in the medial aspect of the knee and, thus, it acts as the primary static stabilizer to valgus stress while providing both additional dynamic stabilization for the medial aspect of the knee and some restraint to anterior translation of the tibia.[4] Therefore, multiple various forces are placed on the MCL simultaneously. Injury to the MCL typically occurs from a direct blow to the outside of the thigh or leg while the foot is planted, producing a direct valgus force on the knee or a valgus stress in combination with tibial external rotation, which frequently occurs in cutting and pivoting sports.[5]

Medial collateral ligament injuries are typically graded from I to III and diagnosed using magnetic resonance imaging (MRI).[3] Grade I MCL injuries are the mildest and characterized by minimally torn fibers, with the integrity of the MCL preserved. Grade II injuries are incomplete tears through the ligament, and valgus laxity can often be appreciated on clinical examination. Grade III tears are the most severe and indicate a complete tear through the MCL. The determination of operative versus nonoperative management of an MCL injury depends on the injury grade.[5,6]

Grade I and II MCL injuries are effectively treated nonoperatively, emphasizing early rehabilitation with mobilization, quadriceps muscle strengthening, and supportive bracing.[6] However, management of isolated grade III MCL injuries remains controversial, as researchers[7] have shown that both nonoperative and operative management of these injuries can result in return to play, with reports of return to full contact play within 9 weeks using nonoperative management. Yet a limitation of this study was that the locations and full descriptions of the MCL tears were not provided.

Although isolated proximal and midsubstance grade III MCL tears have shown excellent healing potential, distal avulsion MCL injuries have displayed poorer healing potential.[8] Surgical intervention is indicated for patients with ongoing knee laxity after nonoperative management or

Table 1. Patients' Characterstics

Variable	No.
Patients	7
Sex, males/females	7/0
Injured knee, left/right	4/3
	No. (%)
Attempted conservative management	3 (42.9)
Position	
Offensive linemen	4 (57.1)
Defensive linemen	1 (14.3)
Tight end	2 (28.6)
	Median (Range)
Age at surgery, y	21 (18–22)
Time to surgery, d	4 (2–67)
Return to noncontact drills, d	120.5 (104–168)
Return to full-contact sport, days	181 (139–204)

severe valgus alignment, intraarticular MCL entrapment, or a large bony avulsion.[8] Similarly, avulsion injuries of the distal MCL at its insertion site on the proximal tibia tend to displace proximally and superficially, allowing interposition of the pes anserine tendons, which interferes with primary healing of a torn MCL, necessitating surgical intervention.[9]

Because of these factors, distal avulsion grade III MCL injuries represent a unique subset of MCL grade III injuries that are best managed with early operative treatment and postoperative rehabilitation. The purpose of our article is to present a standardized rehabilitation protocol for a case series of 7 National Collegiate Athletic Association Division I collegiate football players (D1CFPs) who underwent surgical repair of isolated grade III distal MCL avulsions.

CASE PRESENTATION

Patients

After gaining institutional review board approval, we identified all D1CFPs at our university who underwent MRI for valgus laxity of the knee between 2010 and 2018. From October 2014 to August 2018, seven D1CFPs were identified and evaluated by a single, fellowship-trained, sports medicine orthopaedic surgeon for valgus stress knee instability (Table 1).

Each patient demonstrated gross laxity and no endpoint with valgus stress at 30° of knee flexion and medial joint opening of at least 10 mm, resulting in classification of a grade III MCL injury and inclusion in the study.[10] Routine preoperative MRI was used to identify the injured medial-side structures and guide decision making for an operative plan (Figure 1). The surgical and nonsurgical options and associated risks of treatment of distal MCL injuries were discussed with the patients; surgery was recommended for all. Before undergoing operative intervention, 3 players first attempted nonoperative treatment with a brace in various combinations with platelet-rich plasma injection(s), physical therapy, rest, and nonsteroidal anti-inflammatory drugs.

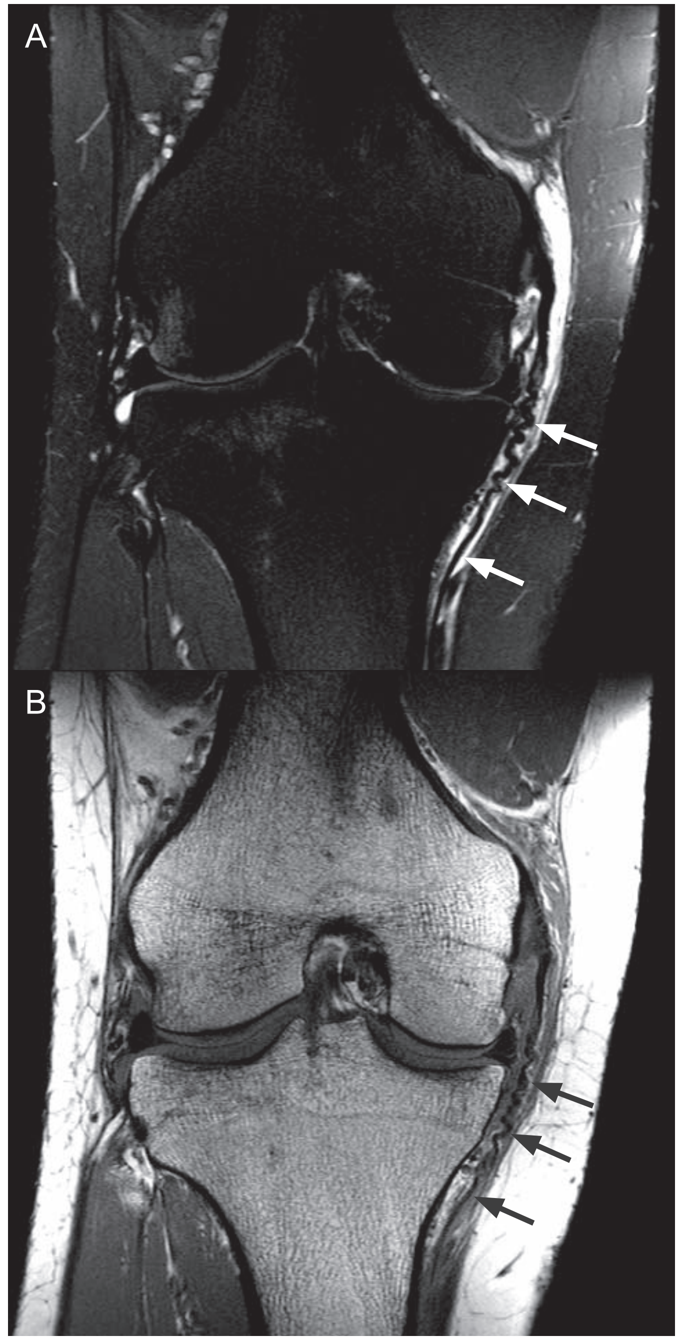

Figure 1. Magnetic resonance imaging. A, Coronal proton density fat saturation and B, coronal proton density T1 images demonstrate avulsion of the medial collateral ligament from its tibial insertion with proximal retraction of the ligament (arrows).

INTERVENTION

Primary repair was performed on all participants (Figure 2). Timelines from surgery to return to contact sport are provided in Table 2. A 4-phase rehabilitation program began on postoperative day 1: (phase I) protection; (II) functional progressions; (III) sport-specific activities; and (IV) supervised sport activities, along with suggested exercises and criteria to advance to the next phase (Table 3). Criteria for interphase progressions and a clinical algorithm for intraphase progressions for phases III and IV (Tables 4 and 5) are discussed in the following sections.

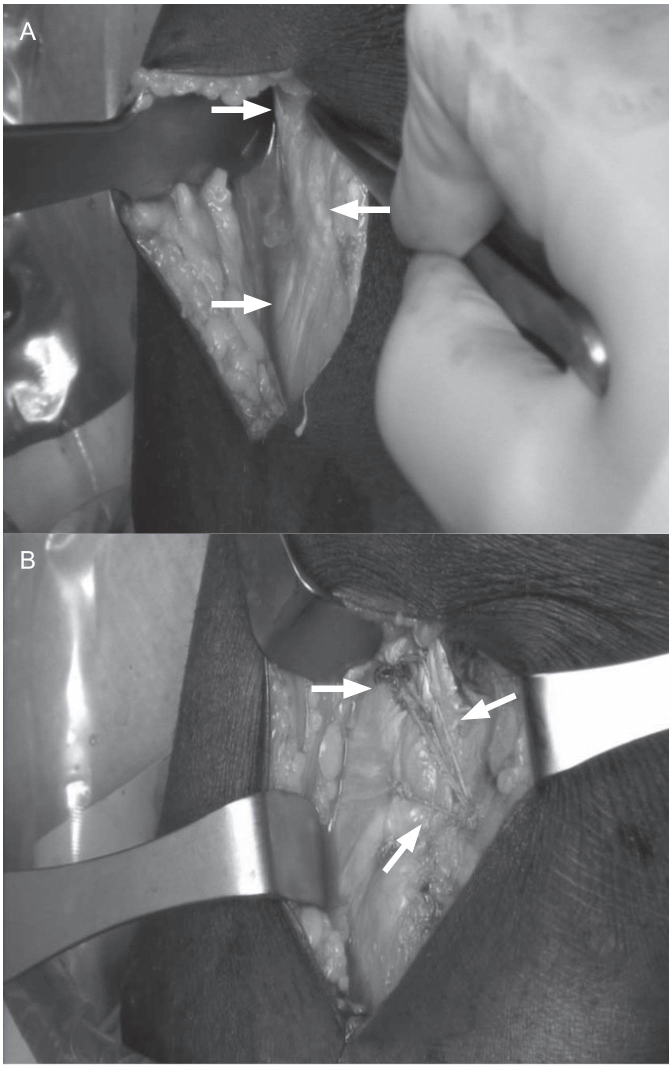

Figure 2. A, Open dissection of the superficial structures to reveal the superficial medial collateral ligament (arrows). B, Surgical repair of the grade III medial collateral ligament avulsion injury using a double-row suture technique (arrows).

Protection (Phase I)

The protection phase began with a non–weight-bearing protocol (4–6 weeks) to allow for proper fixation and soft tissue healing. After 3 weeks, the patients initiated passive range of motion (ROM). Rehabilitative goals at this time were to protect the postoperative knee, eliminate effusion, restore adequate ROM, and mitigate weakness caused by arthrogenic muscle inhibition. Emphasis was placed on controlling knee joint swelling and pain through ice and elevation; regaining appropriate voluntary contractions of the thigh, hip, and ankle musculature; and initiating graded knee motion at 3 weeks. Alhough researchers[3] have argued that delayed passive ROM may increase the risk of stiffness, arthrofibrosis, or the need for manipulation under anesthesia, we encountered no instances of stiffness due to delayed ROM at any point postoperatively.

Functional Progressions (Phase II)

The rehabilitation goals for the functional progression phase were to achieve full active knee ROM, gain trunk and lower extremity strength (>4/5 grade on manual muscle testing), further minimize the isometric quadriceps deficit compared with the uninjured leg to less than 20% (a maximum deficit of 20% is tolerable for rehabilitation protocols of the knee within 6 months of surgery and thus is sufficient for progression to the next phase[11]), initiate generalized aerobic conditioning, perform single-limb balance ($\geq$30 seconds), achieve uncompensated pain-free mobility, and introduce in-line jogging. During this phase, careful progressions were started to begin stressing the ligamentous complexes about the knee. This was done by advancing closed kinetic chain exercises while pre-positioning the knee from a neutral to varus and ultimately a valgus posture. The physical therapist(s) developed an exercise-based intervention to target any balance or mobility deficiencies and permit progression toward a running gait.

Sport-Specific Activities (Phase III)

Participants were advanced to position-specific agility drills, plyometric activities, and a jog-sprint progression. Goals for this phase included a return to football-specific training, normalized sprinting mechanics, and uncompensated multiplanar mobility. Rehabilitation interventions focused on normalizing limb function and lower-quarter strength, movement skills, postural stability, and sport-related agility drills. Higher-level impact training was progressed from the aquatic environment to dynamic surfaces.

Supervised Sport Activities (Phase IV)

During this phase, participants returned to premorbid activity levels. They performed all strengthening and stretching exercises with the team, took part in structured

Table 2. National Collegiate Athletic Association Division I Collegiate Football Players' Progressions From Injury to Return to Contact Sport

Player	Underwent Preoperative Rehabilitation?	Injury to Surgery, d	Surgery to Completion of Phase I, d	Completion of Phase, d			Injury to, d	
				II	III	IV	Noncontact Play	Contact Play
1	Yes	32	28	42	42	20	145	171
2	Yes	32	35	52	56	48	200	236
3	No	3	45	44	15	74	107	192
4	No	2	15	39	25	23	81	112
5	Yes	67	31	45	44	46	187	240
6	No	4	25	42	58	34	135	174
7	No	3	23	43	25	23	96	124

Table 3. Phases of Rehabilitation **Continued on Next Page**

Goals of Phase	Precautions and Contraindications	Suggested Exercises	Criteria to Advance to Next Phase
Phase I: Protection Protect surgical repair Initiate early motion Prevent stiffness Decrease pain, edema, inflammation Minimize muscle atrophy Absence of quadriceps extension lag Educate patient and family if needed	Non–weight bearing for 1–2 wk, toe-touch weight bearing to full weight bearing for 3–6 wks, and crutches for ambulation Manage wound Knee in full extension for first 2 wk Knee flexion to 90° at wk 3–6; minimal increase of ≥15°/wk ROM interventions in slight tibial external rotation to ↓medial collateral ligament load Assess for deep vein thrombosis Avoid painful activities that would create an inflammatory response Remove sutures at 10–14 d postoperatively Discontinue brace by wk 6 if criteria to advance to phase II met	Aerobic conditioning Upper body ergometer Modalities Cryotherapy Edema, pain control through electrical stimulation ROM Knee PROM → AAROM → AROM Ankle pumps Hip, ankle mobility Strength Manual resistance at thigh, hip in all planes Intrinsic toe flexion Ankle isometrics in all planes Proximal hip PNF D1/D2 Balance Weight shifting in all planes	No effusion AROM 0°–90° Absence of extensor lag with active supine straight-legged raise using a 5-lb (2.25-kg) weight
Phase II: Functional progressions Restore knee ROM (~80%) and >4/5 manual muscle testing strength Maintain or improve strength of lower extremity, core musculature Control edema Maintain optimal soft tissue healing environment Increase proprioception, balance, coordination Single-legged balance (≤30 s)	Weight bearing as tolerated to full depending on pain, ROM, soft tissue repair; proceed cautiously if valgus stress persists	Aerobic conditioning Stationary cycling → body weight modified or underwater treadmill training → elliptical Modalities as needed ROM Knee static and PNF stretching Scar mobilizations Strength Open chain isotonics for lower limb Manual resistance to lower extremity PNF strengthening Progressive resistance exercise variations, including lunge, squat, hip hinge, or deadlift Lumbo-pelvic-hip stabilization exercises Proprioception, coordination, balance Address movement impairments Double-limb balance → single-limb balance Knee neutral-biased → varus-biased → valgus-biased closed chain progressions Upper, lower body excursion balance exercises Balance strategy training Low-level multiplanar agility maneuvers	Full AROM Normalized gait patterns: absence of antalgic or compensatory gait patterns Isometric quadriceps index test with ≤20% deficit versus uninvolved extremity Minimal valgus or trunk lean during 10 single-legged squats past ≥60° of knee flexion Able to perform step-down testing without substantial valgus or trunk compensation Sustain static balancing via single-legged balance for ≥30 seconds without falling off base of support
Phase III: Sport-specific activities Return to football-specific training	Abnormal pain, swelling, or edema	Aerobic conditioning Land-based jog → run → sprint progression ROM Self-stretching Strength Continue advancing of resistance exercises outlined in phase II Plyometric progression water → land Olympic lifts Proprioception, coordination, balance Continue to address movement impairments Programmed → reactive coordination drills Agility training (position specific)	Asymptomatic straight-line jogging, running, acceleration, deceleration No compensatory strategies during running-gait cycles (asymmetric turnover, ↑ trunk lean, ↓ knee-flexion angle during stance phases) Ability to cut, change direction at designated points during high-velocity maneuvers (cone drill) Knee isokinetic CON/CON 3-speed (60°/s, 180°/s, 300°/s) testing with ≤20% deficit versus uninvolved extremity

Table 3. Continued From Previous Page

Goals of Phase	Precautions and Contraindications	Suggested Exercises	Criteria to Advance to Next Phase
Phase IV: Supervised sport activities Return to premorbid participation, but avoid "overdo" complex Full return to sport	Abnormal pain, swelling, and edema	Aerobic conditioning Football related ROM Maintenance of knee extension-flexion mobility Strength Return to team lifting Proprioception, coordination, balance Maintenance of dynamic single-limb–stance balance strategies during provocative maneuvers	Criteria for return to play: Asymptomatic and normal postural alignments with sprinting, deceleration, jumping, change of direction Asymptomatic sport-specific multidirectional movements at maximum velocity, speed Able to cut, change direction at designated points during high-velocity maneuvers (cone drill) while fatigued Return to premorbid strength values in weight room

Abbreviations: AAROM, active-assistive range of motion; AROM, active range of motion; CON, concentric; D1, diagonal pattern 1; D2, diagonal pattern 2; PNF, proprioceptive neuromuscular facilitation; PROM, passive range of motion; ROM, range of motion.

aerobic and sport-specific conditioning, and were advised to self-monitor for any change in their condition.

COMPARATIVE OUTCOMES

Seven D1CFPs underwent surgical repair for grade III MCL distal avulsions; their demographic and sport-related information is summarized in Table 1. Of note, 5 players were injured during a season game (71%). One player was injured during a preseason scrimmage game and another at practice. No bilateral knee injuries occurred.

Three athletes did not improve on nonoperative management. One athlete underwent open patellar tendon debridement secondary to chronic tendinopathy, and another required medial patellofemoral ligament reconstruction due to an associated tear with patellar instability. All athletes underwent rehabilitation with the team physical therapist(s) at the university's athletic training facility. Reintegration of the D1CFPs into sport was accomplished in combination with recommendations from the physician, physical therapists, and athletic trainers. The median time from surgery to noncontact drills was 120.5 days (range = 104–168), and the median time from surgery to full-contact sport during practice was 181 days (range = 139–204). One participant required further surgery 3 years later due to a focal chondral injury and complex medial meniscal injury.

Table 4. Clinical Algorithm for Intraphase Progressions for Phase III

Goals	Therapeutic Interventions	Precautions	Recommendations
Normalize strength	Progressive resistive exercise	Closed chain exercise begins with smaller joint angles and above 90°, minimizing dynamic valgus. Achieve nearly symmetric closed chain strength with unilateral complex movements before incorporating double-limb movements to avoid compensatory weight shift.	Continue to progress strengthening of the dynamic knee stabilizers and supporting proximal and distal musculature. Focus on unilateral complex movements to augment strengthening before focusing on bilaterally based movements. Both open and closed chain are appropriate if prescribed in graded, regimented fashion.
Address movement impairments	Motor control and proprioceptive drills	Screen for intrinsic and extrinsic risk factors (eg, tibial torsion and posture).	Identify predisposing factors (eg, weak lumbo-pelvic-hip complex [ie, hip external rotators and hip abductors], excessive static and dynamic foot pronation, genu valgum, and increased Q-angle). Screen for balance and proprioceptive deficits with daily and sport-specific activities.
Low-speed running	Aquatic therapy, lower body positive pressure treadmill, and land-based running	Criteria to run include ≤20% deficit compared with the uninvolved limb during isometric quadriceps testing at 60°, symmetric active and passive end range of motion, and absence of joint effusion. Typically, postoperative physician clearance is permitted at 12 wk.	Turnover and ground contact time need to be cued during slower speeds. Weight-bearing loads should be progressed as follows: deep-well running with a buoyancy belt, pool running, lower body positive pressure treadmill, and land-based running.
Deceleration	Low-speed deceleration and landing mechanics	Be aware of rapid braking impulses and inability to properly weight shift. If not properly executed, an aberrant movement pattern will develop.	Begin to decelerate from slower speeds within larger ranges; progress speed and decrease distance. Begin double-limb landing mechanics, progressing to single-limb landing while monitoring knee stiffness.

Table 5. Clinical Algorithm for Intraphase Progressions for Phase IV

Goals	Therapeutic Interventions	Precautions	Comments
High-speed running	Aquatic therapy, lower body positive pressure treadmill, land-based running	Monitor volume, distance, and intensity; do not increase several variables at once.	Continue to monitor mechanics with jogging and running. Incrementally increase speed in regimented fashion.
Power-based functional strength	Plyometrics, agility training	Observe for signs of effusion; monitor the amount of ground contacts, never increasing by >25% per session.	Once landing mechanics look symmetric without excessive need for cueing, plyometrics are typically allowed at 16 wk postoperatively. Double-limb contacts should be mastered before introducing single-limb contacts. Footwork and agility training should precede more advanced movements.
Sport-specific movements	Change of direction, cutting	Begin at low speeds and monitor patient's kinesthetic awareness of limb with agility drills before any high-speed cutting maneuvers.	Before performing any of these activities, patient needs to display ≤20% deficit versus uninvolved lower extremity with isokinetic concentric/concentric testing. Progress from change-of-direction movements to breaking down to cutting to rapid cutting maneuvers.
Satisfactory physical performance scores	Isokinetic testing, physical performance measures	Report any signs or symptoms to physician for further evaluation. Monitor volume with sport reintegration.	Satisfactory scoring with physical performance measures. Assess overall clinical presentation during graded exposure to sport-specific activities.

For the players who underwent initial nonoperative management, the median times from surgery to noncontact and then to contact sport during practice were 187 days (range = 145–200) and 236 days (range = 171–240), respectively. Players who underwent immediate operative management (within 4 days) returned to noncontact sport and then contact sport during practice in median times of 101.5 days (range = 81–135) and 149 days (range = 112–192), respectively. All patients were completely stable to valgus stress at the final follow-up examination before being cleared for return to sport.

DISCUSSION

In this case series, 7 D1CFPs underwent repair of a grade III distal avulsion MCL injury. All participants performed the same rehabilitation protocol and successfully returned to sport. Prior researchers[7,12] have described how patients with lower grade MCL injuries could be treated nonoperatively with excellent outcomes. However, in a longer follow-up study,[13] nonoperative management of grade III MCL sprains led to poorer outcomes with persistent medial instability, dysfunction of the anterior cruciate ligament, muscle weakness, and posttraumatic osteoarthritis of the injured knee. Indeed, after a trial of nonsurgical treatment, 3 participants in our study had persistent medial-sided knee pain and instability that precluded return to play. These players also experienced delayed returns to both noncontact and contact sport compared with those who underwent immediate operative management, suggesting that the latter allowed for quicker return to sport.

Most authors who addressed the management of patients with MCL injuries did not classify or describe the site of injury, which makes the true incidence and associated treatment outcomes of distal injuries difficult to determine. Researchers have suggested that tibial-sided MCL injuries did not result in excellent outcomes with nonoperative management. Wilson et al[14] showed that nonsurgical treatment of grade III MCL injuries was unsuccessful in a group of athletes due to persistent instability. These athletes had complete detachments of the distal MCL from the tibia noted on MRI and required delayed surgical intervention. The authors thus recommended early surgical repair for patients with distal grade III ruptures.

A complete and inclusive rehabilitation program is critical to a positive outcome, but no standardized MCL protocol exists. Research on nonoperative and postoperative rehabilitation protocols involved observational reports and case studies.[12,15,16] No level I studies in which the authors compared rehabilitation protocols have been published. Therefore, treatment decisions for each patient should be based on the characteristics and nature of the injury.

Our study had limitations: namely that it was a small case series of D1CFPs with distal grade III MCL tears in whom no objective data were collected, nor was a control group included. Therefore, although all D1CFPs successfully returned to sport, we cannot conclude that immediate surgical management led to superior long-term objective outcomes compared with patients who pursued nonsurgical management. However, the cohort that first attempted nonsurgical management nonetheless required surgery due to persistent instability.

Furthermore, 5 participants were injured in the second half of the season. Given the lengthy offseason in American football, this may have resulted in a longer time to return to competitive play than if the injury had occurred in the preseason or early in the season. Large, objective, prospective studies are needed to validate these initial results. Nevertheless, we demonstrated excellent outcomes with immediate surgical repair and a stepwise rehabilitation and return-to-play protocol.

Clinical Bottom Line

Primary repair of tibial-sided MCL avulsions may be a less invasive and more effective and reliable treatment option in football players that can provide improved valgus stability and allow a predictable and quicker return to play at the preinjury level. In our patients, surgical repair along with our detailed rehabilitation protocol resulted in satisfactory return-to-play outcomes. Therefore, this protocol may serve as an alternative option for treatment. Larger prospective studies are needed to further validate these findings.

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