

Nonoperative Treatment for Partial Ruptures of the Lateral Collateral Ligament Occurring in Combination With Complete Ruptures of the Anterolateral Ligament



A Common Injury Pattern in Brazilian Jiu-Jitsu Athletes With Acute Knee Injury

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Background: Combined partial lateral collateral and complete anterolateral ligament (PLCCALL) injuries are a specific injury pattern seen in Brazilian jiu-jitsu (BJJ) because of the knee varus-flexion mechanism that frequently occurs during grappling.

Purpose/Hypothesis: The purpose of this study was to evaluate the incidence of this injury pattern in a series of BJJ athletes with an acute knee injury and to evaluate clinical and functional outcomes after nonoperative management at a minimum follow-up of 1 year. Our hypotheses were that PLCCALL injuries are common in BJJ and that nonoperative treatment is associated with excellent clinical outcomes and return to the preinjury level of sport.

Study Design: Case series; Level of evidence, 4.

Methods: All BJJ athletes who presented with an acute knee injury between July 2013 and June 2017 and who underwent magnetic resonance imaging (MRI) of the knee were included. A specific emphasis was placed on identifying those whose imaging demonstrated PLCCALL injury. Clinical evaluation included physical examination as well as Lysholm and International Knee Documentation Committee (IKDC) scores.

Results: Of the 27 patients analyzed, 7 (25.9%) had MRI-proven PLCCALL injuries. The mean follow-up after nonoperative management was 41.3 months. The mean IKDC and Lysholm scores were 94 and 92 before the injury, 26 and 36 at the initial assessment after the injury, and 83 and 78 at 12-month follow-up, respectively ($P < .00001$). All 7 patients had returned to their preinjury level of sports by the 12-month follow-up. The mean time between injury and return to competition level was 4.7 months (range, 4–6 months).

Conclusion: PLCCALL injury is a specific but infrequent injury pattern in BJJ. The prognosis of this injury after nonoperative treatment appears to be excellent. Improved functional scores (IKDC and Lysholm) and changes on MRI demonstrated that the anterolateral ligament has intrinsic healing potential, as the images showed complete healing of the previously documented rupture of the anterolateral ligament from its proximal attachment.

Keywords: anterolateral ligament; fibular collateral ligament; Brazilian jiu-jitsu

The past decade has seen a significant increase in the popularity of Brazilian jiu-jitsu (BJJ).^{2,24} This increase is due in part to the success of BJJ techniques in the much larger

sport of mixed martial arts.^{14,15,20} Athletes begin BJJ from a standing position, but most of the combat takes place in groundwork. The aim is to make the opponent submit by means of choke, joint locks (wrist, elbow, knee, and ankle locks), or pressure techniques.^{2,17}

Despite the popularity of BJJ internationally, little is known about the incidence and spectrum of injuries in this

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sport.^{17,24} Scoggin et al²⁴ reported an injury rate of 9.2 per 1000 athlete-exposures during BJJ competition, and the knee was the second most common area of orthopaedic injury (19.4% of all injuries). Of particular note, 57% of knee injuries involved the lateral collateral ligament (LCL), but detailed clinical and radiological evaluation was not reported.²⁴

Claes et al⁶ proposed the term *lateral collateral ligament complex* (LCLC) to encompass both the LCL and the anterolateral ligament (ALL).⁶ Since that time, considerable discussion has been published in the literature regarding the precise anatomic features of the anterolateral aspect of the knee, and the term *LCLC* has been popularized. However, numerous authors have noted that because the proximal fibers of the LCL and ALL are often integrated, it would be logical to consider that combined injuries may occur.^{5,11,13,16} Davis et al⁷ reported a single case of combined partial rupture of the LCL and complete rupture of the ALL in a BJJ athlete.

The aim of this study was therefore to evaluate the incidence of this specific injury pattern in a large series of BJJ athletes with an acute knee injury and to evaluate clinical and functional outcomes with a minimum follow-up of 1 year.

METHODS

Institutional review board approval was granted for this study. All BJJ athletes presenting with an acute knee injury (within 2 weeks) between July 1, 2012, and June 30, 2017, at Hospital Madre Teresa (Belo Horizonte, Brazil) were invited to participate in the study. Signed informed consent was obtained, and patients were considered for study eligibility. Patients were excluded if they had a history of previous surgery, infection, arthritis, or injury to the ipsilateral knee or a concurrent ligament injury in addition to partial LCL and complete ALL injury.

All patients underwent standard, acute clinical examination and evaluation of the knee via plain radiographs (non-weightbearing anteroposterior and lateral views and varus stress views) (Figure 1) and magnetic resonance imaging (MRI) within 1 week of the initial presentation, which varied from 1 to 3 weeks of injury.¹⁵ The stress views were performed and interpreted by the senior surgeon (E.F.T.) according to protocol described by LaPrade et al.¹⁸ MRI was performed with a 1.5-T magnet with a wide-bore configuration (Magnetom Avanto; Siemens). Standard reporting practice for knee MRI was followed, and particular emphasis was placed on identifying injury to the anterolateral knee structures (Figure 2).^{9,26} In patients with a combined

partial rupture of the LCL and a complete rupture of the ALL, a specific effort was made to determine the precise mechanism of injury, including video analysis of trauma when such videos were available.

MRI Evaluation

MRI scans were evaluated by a radiologist with more than 10 years of experience in musculoskeletal radiology. Previously described radiological and anatomic descriptions were used as a basis for interpretation.^{9,26} The ALL was considered normal if continuous low signal intensity fibers were seen traversing from the lateral femoral epicondylar region to the anterolateral tibia. The ALL was considered to be abnormal and was classified according to Muramatsu et al²¹ if any of the following features were observed: complete disruption of the ligament, abnormal contour or irregularity of ALL fibers, or the presence of ligamentous edema. LCL injuries were graded (0-3) according to equivalent Schweitzer et al²³ criteria for the medial collateral ligament. If the contour of the LCL was irregular or if ligamentous edema existed, then the LCL was considered to be abnormal. All LCL injuries were considered significant for the purpose of this study, according to Pacheco et al.²² For both the LCL and ALL, if the contour of the structures analyzed was irregular or if ligamentous edema existed, then the radiologists considered the structure to be abnormal. If only periligamentous edema existed, with identifiable, continuous low signal intensity fibers, the ligament was considered intact.^{21,22}

Rehabilitation

All patients with combined LCL and ALL injuries were treated nonoperatively. This treatment consisted of immediate partial weightbearing with a hinged knee brace (Ossur UK) locked in knee extension for 2 weeks. At this stage, full weightbearing was allowed, as was unrestricted motion within the brace for a further 4 weeks. All braces were discarded at 6 weeks after the injury. Patients began physical therapy at 2 weeks. Therapy included use of a continuous passive motion machine and application of a cold or compression device (Cryocuff; DJ Orthopaedics). Once inflammation and swelling had subsided and full symmetrical range of motion was achieved, strength and functional training were progressed gradually with a view to returning to sports participation. Patients typically resumed moderate activity (strengthening and aerobic training in the gym, avoiding pivot activities) 2 months after injury and achieved a full return to jiu-jitsu competition at 3 to 6 months.

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Ethical approval for this study was obtained from Hospital Madre Teresa.

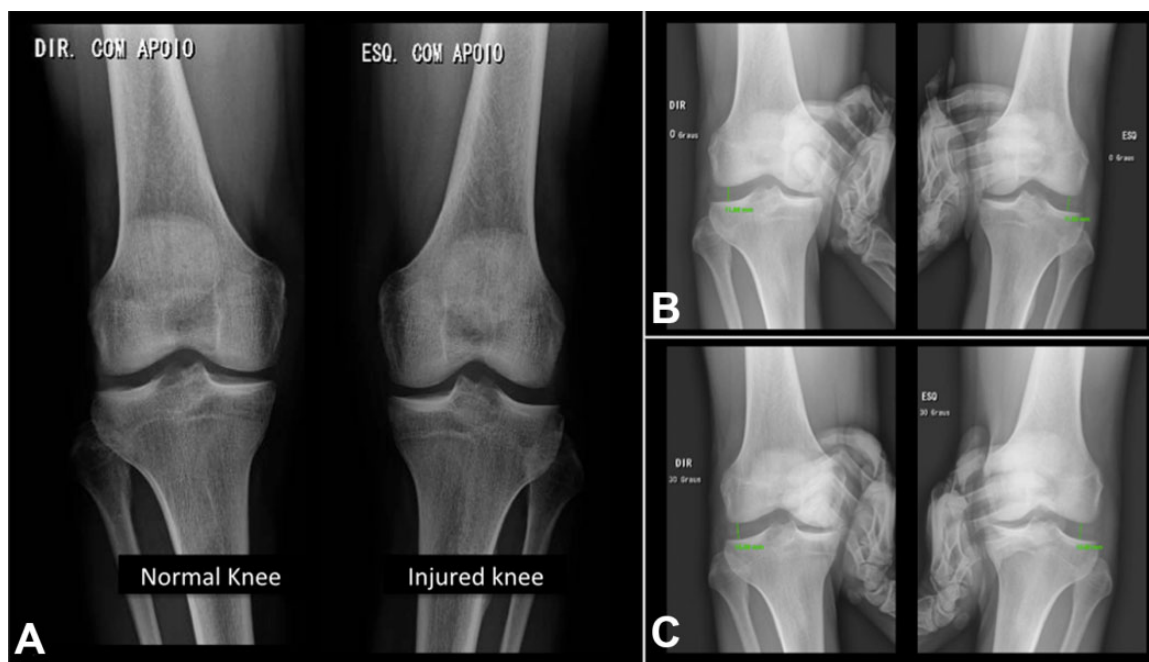


Figure 1. Radiographic images comparing the normal (right) and injured (left) sides: (A) anteroposterior (AP) view; (B) AP stress view, 0° of flexion; (C) AP stress view, 30° of flexion.

Outpatient Follow-up

The senior surgeon reviewed all patients at 6 weeks after injury, at 3, 6, and 12 months, and beyond this time if the patient returned for evaluation of another injury. Clinical outcome scores including the International Knee Documentation Committee (IKDC) score and Lysholm score were recorded.^{4,25} All of the study patients were training under the supervision of jiu-jitsu centers, and preinjury scores were obtained from previous physical therapy records. Follow-up MRI to evaluate healing was performed only in 2 patients who had repeat imaging to evaluate new injury. This additional imaging provided the opportunity to evaluate the healing potential of the ALL.

Data Analysis

Descriptive data (mean, standard deviation, range, proportion) are reported for the entire patient cohort. SPSS Statistics for Windows, version 20.0 (IBM Corp) was used for all statistical analyses. Differences between means were tested for normal distribution by the D'Agostino-Pearson test, and the differences between the averages were calculated by Student *t* test. A *P* value of $\leq .05$ was considered statistically significant.

RESULTS

Of the 27 patients analyzed, 7 (25.9%) had MRI-proven partial injury to the LCL and complete ALL rupture. All 7 patients were male, with a mean age of 33 years (± 10.5 years). The mean follow-up period was 41.3 months (range,

22.1-60.5 months). The mean IKDC score was 94 before the injury, 26 (± 3.1) at the initial assessment, and 83 (± 6.4) at the 12-month postinjury follow-up ($P < .00001$). The mean Lysholm score was 92 before the injury, 36 (± 9.2) at the initial assessment, and 78 (± 10) postinjury ($P < .00001$). All 7 patients returned to their preinjury level of sport. The mean time between injury and return to competition level was 4.7 months (range, 4-6 months).

In all 7 patients with a combined injury, MRI evaluation demonstrated a high-grade partial-thickness tear of the LCL (Schweitzer grade 2) at the femoral attachment and complete rupture of the ALL from its proximal attachment with the distal attachment remaining intact. Varus stress physical examination findings and radiography demonstrated that there was no increase in lateral compartment opening compared with the uninjured side in all patients ($P > .05$).

In the 2 patients who underwent repeat MRI (for a new knee injury) at approximately 12 months after the previous imaging, complete healing of the previously documented partial ruptures of the LCL and ALL, without any evidence of anatomic abnormalities, was demonstrated (Figure 3).

DISCUSSION

The most important finding of the present study was that partial rupture of the LCL and complete rupture of the ALL occurred in the current series at a rate of approximately 25.9% of BJJ athletes presenting with an acute knee injury. The rate of occurrence is sufficient to highlight this specific pattern of injury to clinicians who treat BJJ athletes. To

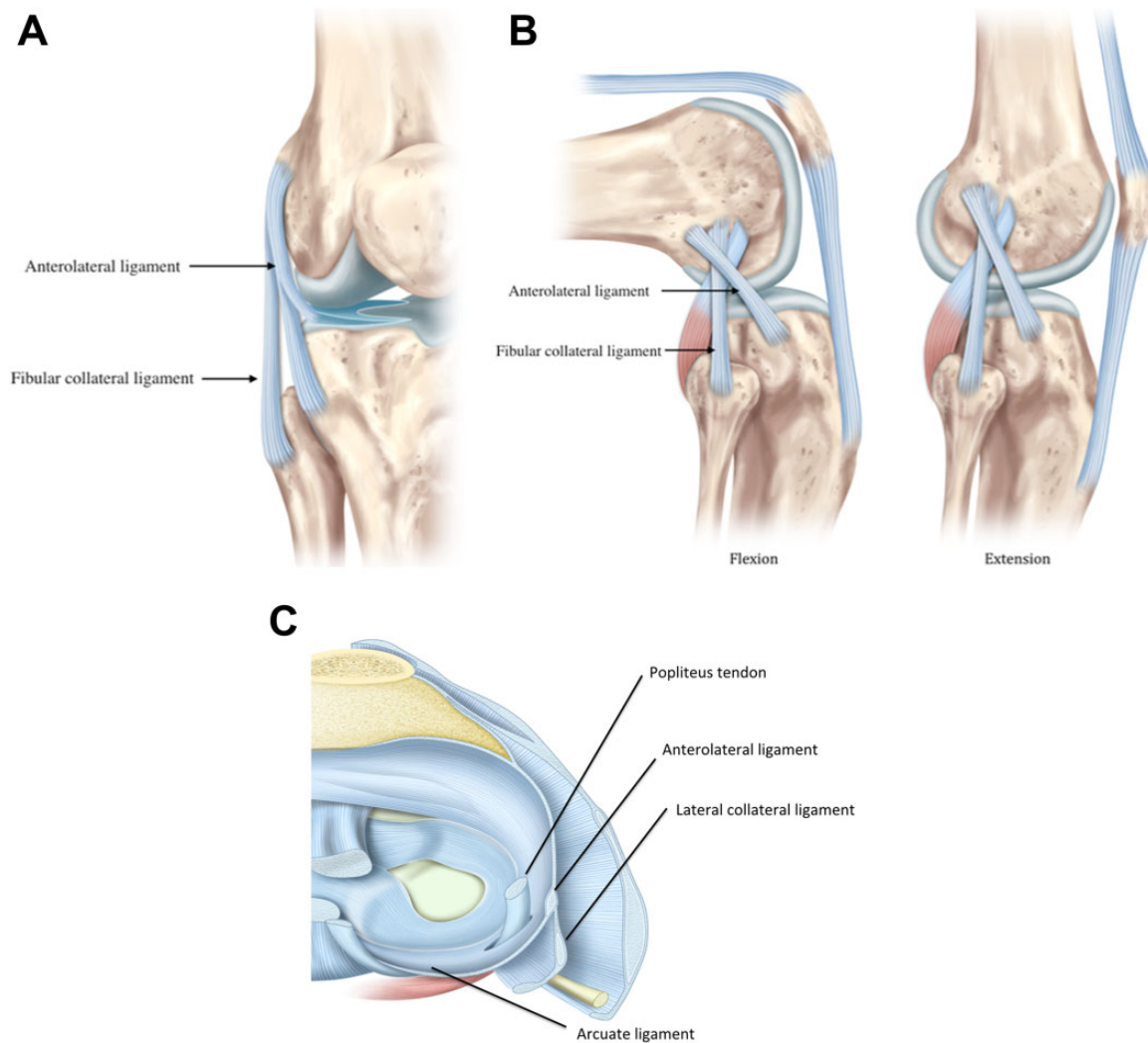


Figure 2. Illustration demonstrating the normal anatomic features of the lateral corner of a right knee: (A) coronal view; (B) sagittal views in flexion and extension; (C) axial view.

our knowledge, this injury pattern in BJJ has previously been described only in a single case report.⁷

The practice of BJJ has increased exponentially all over the world in the past few decades.^{17,24} As a consequence of this growth, researchers have strived to enhance the quality of investigations into physical and physiological responses to training, combat simulation, and prevention of lesions in BJJ.^{1-3,8,14,15} Little is known about injuries in this sport, and specific lesions involving the knee have not been well described. Many dynamic positions occur during BJJ competitions; one of these, the open guard, has evolved extensively in recent years. Multiple variations of this position and their associated techniques include intricate entanglement of the limbs of both combatants, ultimately leading to a significant increase in twisting and varus-valgus injuries of the lower extremities.^{1,2,7,8,14,19} It is therefore helpful to understand the specific mechanism involved when evaluating an injured knee, and video footage can be particularly useful (Figure 4 and Video Supplement).

Davis et al⁷ reported combined partial LCL and complete ALL rupture in a case series of 2 patients. One of these was a BJJ athlete and the other was a rock climber. Similar to the current series, the mechanism of injury in both cases reported by Davis et al⁷ was a varus force on a flexed knee, with varying degrees of external rotation. This is important to highlight for 2 reasons. First, this specific mechanism of injury should raise the index of suspicion for this injury pattern when one is evaluating acutely injured knees, particularly in BJJ athletes. Second, ALL ruptures more frequently occur with a typically valgus-internal rotation injury in a knee with acute anterior cruciate ligament (ACL) injury (up to 90%).^{10,12,21} As a result, in the absence of ACL injury or the typical mechanism leading to it, radiologists may not specifically assess the ALL, unless the request for MRI highlights that injury to this structure should be considered with the mechanism described above. Interestingly, all 7 cases in the present series involved complete disruption of the ALL and partial injury to the LCL

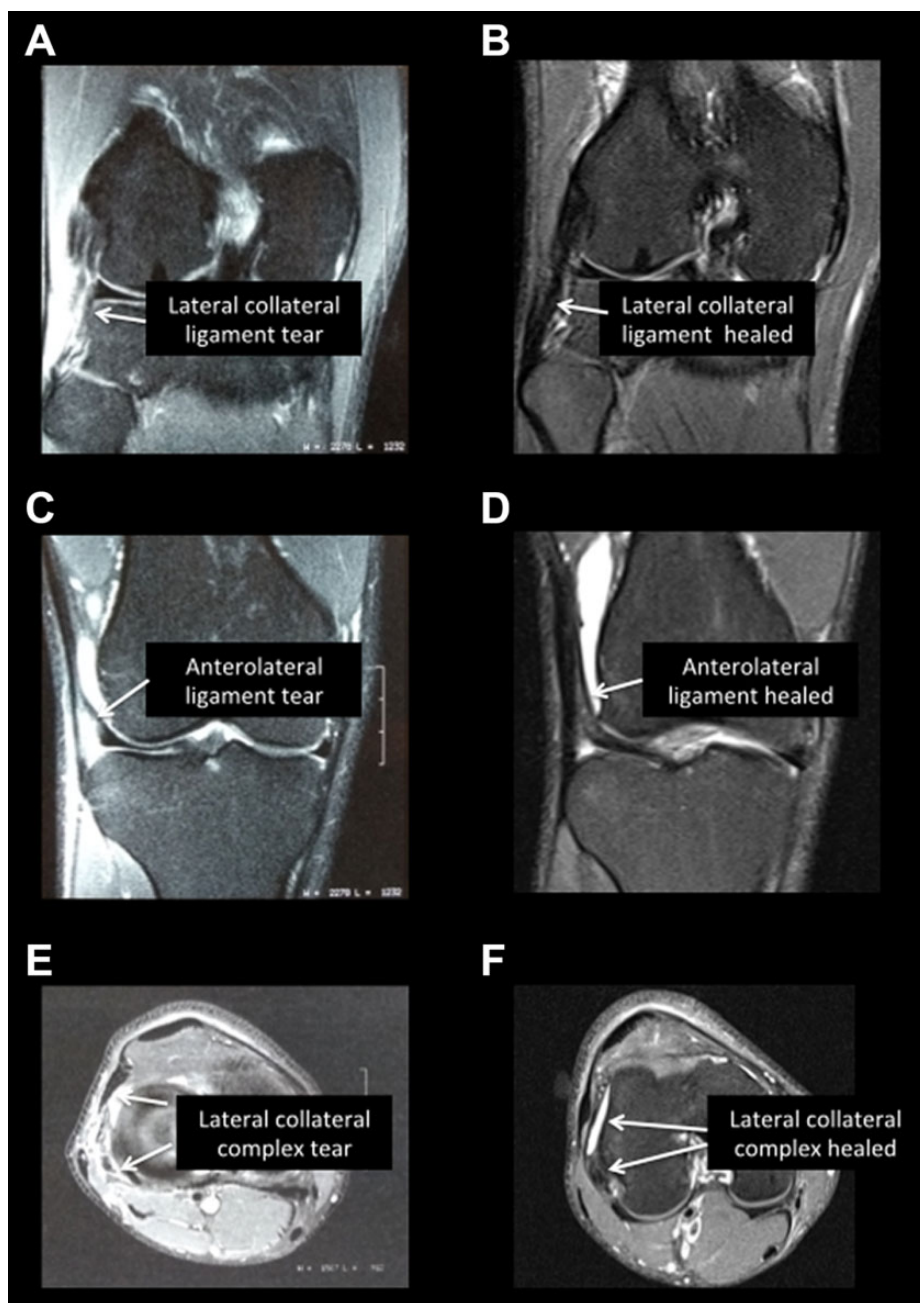


Figure 3. Magnetic resonance images of the partial lateral collateral ligament (LCL) and complete anterolateral ligament (ALL) immediately after injury and at 1 year of follow-up: (A, B) coronal T2-weighted images demonstrating the LCL; (C, D) coronal T2-weighted images demonstrating the ALL; (E, F) axial T2-weighted images demonstrating the LCL complex.

from their proximal attachments. In the setting of ACL injury, ALL ruptures are typically tibial sided, and this difference probably reflects the different forces encountered at the time of injury.

Consistent with our experiences with combined partial rupture of the LCL and complete rupture of the ALL in the current study, Davis et al⁷ also described full return to sport after nonoperative treatment using a similar rehabilitation protocol. This suggests that nonoperative treatment carries a high likelihood of return to competition. The mean

duration of time between injury and return to sport was 4.7 months (range, 4-6 months), and this is useful information for athletes and those who treat them. This finding is broadly consistent with the cases reported by Davis et al,⁷ who described return to competition in a BJJ athlete at 7 months and return to full function in a rock climber at 6 months.

A further important finding of the current study was that partial LCL and complete ALL injuries have the potential to heal with nonoperative management, as proven by MRI

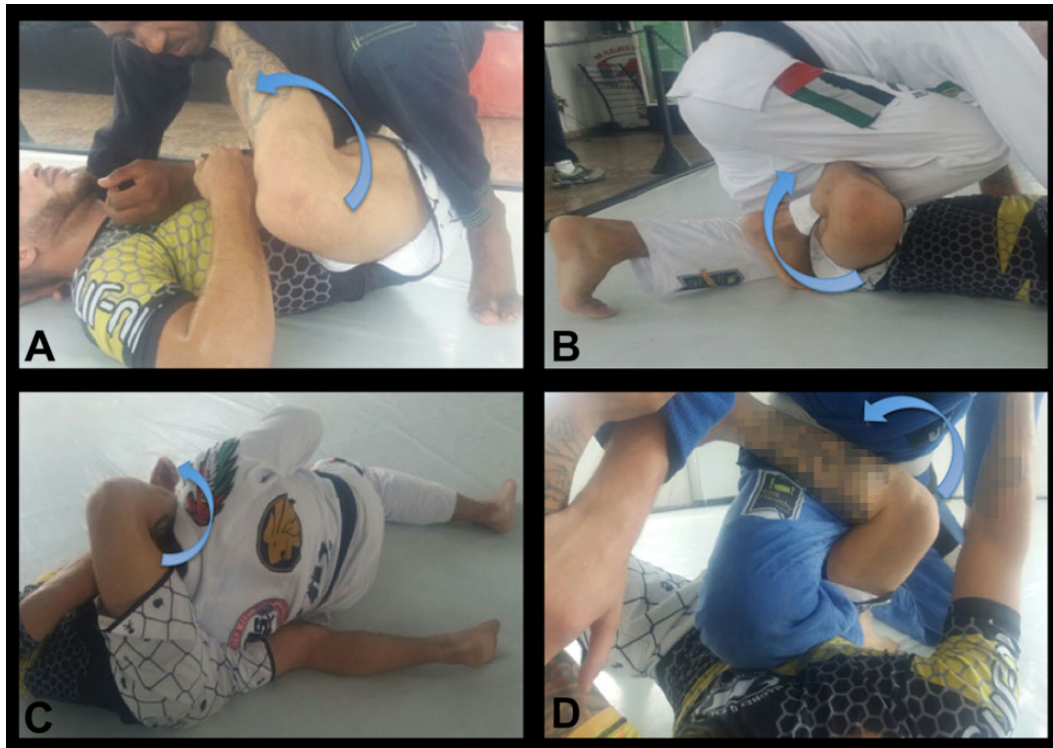


Figure 4. Photographs of the major positions in Brazilian jiu-jitsu related to this injury pattern: (A) Gogoplata; (B) De la Riva guard; (C) bottleneck; (D) 50/50 guard.

evaluation in 2 patients. Debate in the literature has addressed whether ALL injuries can heal with nonsurgical treatment. Muramatsu et al²¹ reported a significantly lower rate of ALL injuries in chronic ACL-injured knees compared with acutely ACL-injured knees and postulated that this may be due to an intrinsic healing potential. The authors recommended longitudinal study to evaluate this concept further. To our knowledge, the current study is the first to evaluate and confirm the intrinsic healing potential of complete ALL ruptures using MRI evaluation.

Limitations

The main limitations of this study are that the series comprised only 7 cases and follow-up imaging was available for only 2 of the 7 patients. Larger series are required to examine more precisely the spectrum of recovery after this injury and gain a more accurate impression of its incidence. However, the overall cohort of 27 acutely injured knees in BJJ athletes represented a significant clinical experience and a considerably larger volume of cases compared with previously published literature evaluating knee injuries in this sport.

CONCLUSION

Clinicians treating BJJ athletes with acute knee injuries should hold an appropriate index of suspicion for partial LCL rupture and complete rupture of the ALL based on the high frequency with which this injury was observed in this study. MRI evaluation in a limited number of patients

demonstrated that the ALL has intrinsic healing potential and that nonoperative treatment appears to be associated with excellent outcomes based on return to the preinjury level of sport in all athletes in this series.

A Video Supplement for this article is available at <http://journals.sagepub.com/doi/suppl/10.1177/2325967118822450>.

REFERENCES

1. Andreato LV, Julio UF, Goncalves Panissa VL, et al. Brazilian jiu-jitsu simulated competition, part II: physical performance, time-motion, technical-tactical analyses, and perceptual responses. *J Strength Cond Res.* 2015;29(7):2015-2025.
2. Andreato LV, Lara FJD, Andrade A, Branco BHM. Physical and physiological profiles of Brazilian jiu-jitsu athletes: a systematic review. *Sports Med Open.* 2017;3(1):9.
3. Andreato LV, Santos JF, Esteves JV, Panissa VL, Julio UF, Franchini E. Physiological, nutritional and performance profiles of Brazilian jiu-jitsu athletes. *J Hum Kinet.* 2016;53:261-271.
4. Bollen S, Seedhom BB. A comparison of the 276 Lysholm and Cincinnati knee scoring questionnaires. *Am J Sports Med.* 1991;19(2):189-190.
5. Caterine S, Litchfield R, Johnson M, Chronik B, Getgood A. A cadaveric study of the anterolateral ligament: re-introducing the lateral capsular ligament. *Knee Surg Sports Traumatol Arthrosc.* 2015;23(11):3186-3195.
6. Claes S, Vereecke E, Maes M, Victor J, Verdonk P, Bellemans J. Anatomy of the anterolateral ligament of the knee. *J Anat.* 2013;223(4):321-328.

7. Davis BA, Hiller LP, Imbesi SG, Chang EY. Isolated lateral collateral ligament complex injury in rock climbing and Brazilian jiu-jitsu. *Skeletal Radiol.* 2015;44(8):1175-1179.
8. Detanico D, Dellagrana RA, Athayde MS, Kons RL, Goes A. Effect of a Brazilian jiu-jitsu-simulated tournament on strength parameters and perceptual responses. *Sports Biomech.* 2017;16(1):115-126.
9. Devitt BM, Whelan DB. Physical examination and imaging of the lateral collateral ligament and posterolateral corner of the knee. *Sports Med Arthrosc.* 2015;23(1):10-16.
10. Ferretti A, Monaco E, Fabbri M, Maestri B, De Carli A. Prevalence and classification of injuries of anterolateral complex in acute anterior cruciate ligament tears. *Arthroscopy.* 2017;33(1):147-154.
11. Helito CP, Demange MK, Bonadio MB, et al. Anatomy and histology of the knee anterolateral ligament. *Orthop J Sports Med.* 2013;1(7):2325967113513546.
12. Helito CP, Helito PV, Costa HP, et al. MRI evaluation of the anterolateral ligament of the knee: assessment in routine 1.5-T scans. *Skeletal Radiol.* 2014;43(10):1421-1427.
13. Herbst E, Albers M, Burnham JM, Fu FH, Musahl V. The anterolateral complex of the knee. *Orthop J Sports Med.* 2017;5(10):2325967117730805.
14. Jensen AR, Maciel RC, Petrigliano FA, Rodriguez JP, Brooks AG. Injuries sustained by the mixed martial arts athlete. *Sports Health.* 2017;9(1):64-69.
15. Ji M. Analysis of injury types for mixed martial arts athletes. *J Phys Ther Sci.* 2016;28(5):1544-1546.
16. Kraeutler MJ, Welton KL, Chahla J, LaPrade RF, McCarty EC. Current concepts of the anterolateral ligament of the knee: anatomy, biomechanics, and reconstruction. *Am J Sports Med.* 2018;46(5):1235-1242.
17. Kreiswirth EM, Myer GD, Rauh MJ. Incidence of injury among male Brazilian jiu-jitsu fighters at the World Jiu-Jitsu No-Gi Championship 2009. *J Athl Train.* 2014;49(1):89-94.
18. LaPrade RF, Heikes C, Bakker AJ, Jakobsen RB. The reproducibility and repeatability of varus stress radiographs in the assessment of isolated fibular collateral ligament and grade-III posterolateral knee injuries: an in vitro biomechanical study. *J Bone Joint Surg Am.* 2008;90(10):2069-2076.
19. Lima PO, Lima AA, Coelho AC, et al. Biomechanical differences in Brazilian jiu-jitsu athletes: the role of combat style. *Int J Sports Phys Ther.* 2017;12(1):67-74.
20. McClain R, Wassermen J, Mayfield C, Berry AC, Grenier G, Suminski RR. Injury profile of mixed martial arts competitors. *Clin J Sport Med.* 2014;24(6):497-501.
21. Muramatsu K, Saithna A, Watanabe H, et al. Three-dimensional magnetic resonance imaging of the anterolateral ligament of the knee: an evaluation of intact and anterior cruciate ligament-deficient knees from the Scientific Anterior Cruciate Ligament Network International (SANTI) Study Group. *Arthroscopy.* 2018;34(7):2207-2217.
22. Pacheco RJ, Ayre CA, Bollen SR. Posterolateral corner injuries of the knee: a serious injury commonly missed. *J Bone Joint Surg Br.* 2011;93(2):194-197.
23. Schweitzer ME, Tran D, Deely DM, Hume EL. Medial collateral ligament injuries: evaluation of multiple signs, prevalence and location of associated bone bruises, and assessment with MR imaging. *Radiology.* 1995;194(3):825-829.
24. Scoggin JF III, Brusovanik G, Izuka BH, Zandee van Rilland E, Geling O, Tokumura S. Assessment of injuries during Brazilian jiu-jitsu competition. *Orthop J Sports Med.* 2014;2(2):2325967114522184.
25. Tegner Y, Lysholm J. Rating systems in the evaluation of knee ligament injuries. *Clin Orthop Relat Res.* 1985;198:43-49.
26. Temponi EF, de Carvalho Junior LH, Saithna A, Thauinat M, Sonnery-Cottet B. Incidence and MRI characterization of the spectrum of posterolateral corner injuries occurring in association with ACL rupture. *Skeletal Radiol.* 2017;46(8):1063-1070.