Knee Surgery, Sports Traumatology, Arthroscopy (2021) 29:3508–3511
https://doi.org/10.1007/s00167-020-06008-2

EDITORIAL

The ankle syndesmosis pivot shift "Are we reviving the ACL story?"

Thomas Tampere[1,2] · **Pieter D'Hooghe**[1]

Received: 4 February 2020 / Accepted: 16 April 2020 / Published online: 25 April 2020

Abstract
In recent literature, there is a growing interest for the high ankle sprain with emerging evidence on biomechanical behavior, function, injury, and treatment. Interpretation of emerging publications on the distal tibiofibular syndesmosis may raise questions about striking similarities with the anterior cruciate ligament function and pivot-shift mechanism of injury in the knee. This editorial note puts to question whether identical entities, a continuum or separate injuries are faced by contemplating on the mechanism of injury, diagnostics, treatment, and outcome.

Keywords ACL · Knee · Syndesmosis · Ankle · High ankle sprain

Anatomy–mechanism of injury–biomechanics

In recent literature, there is a growing interest in the biomechanical behavior, function, injury mechanism, and individualized treatment of high ankle sprains. Thoughtful interpretation of these publications on the distal tibiofibular syndesmosis may raise questions about striking similarities with the anterior cruciate ligament (ACL) function and mechanism of injury to the knee. Consequently, the question then is whether we are looking at identical entities, a continuum or separate injuries? [6, 9, 10, 17, 18, 26, 28].

A rapid pivoting ankle dorsiflexion in valgus (pronation) with a forceful external rotation of the calcaneo–talar–fibular complex relative to the tibia on a fixed forefoot is the most common mechanism of a high ankle sprain. Consequently, this may lead up to a distal ankle syndesmotic injury. As the talus rotates in the mortise, the fibula rotates externally and moves posteriorly and laterally. This mechanism separates the distal tibial and fibula with sequential tearing of the anterior inferior tibiofibular ligament (AITFL), the interosseus ligament (IOL), and in conjunction the (deep) deltoid ligament. In gross instability, the posterior inferior tibiofibular ligament (PITFL) might be involved, presenting as a ligament tear, tibial avulsion, or edema [4, 5, 18, 29, 30]. Striking similarities of this ankle mechanism with the classic non-contact valgus rotation trauma of the femur (external rotation) relative to the tibia in the knee, causing an ACL rupture in the knee, were observed by us [11, 13, 21]. In both mechanisms, a pivoting moment on a fixed forefoot or fully fixed foot is seen in respectively distal syndesmotic ankle or ACL knee injuries. Can it be hypothesized that this is a crucial factor to sustain one injury over another? (Fig. 1a, b).

Latest biomechanical insights in syndesmotic injuries with sequential cutting of the AITFL, IOL, and in conjunction the deltoid ligament revealed a multidirectional instability occurring in the coronal, sagittal, and transverse planes. These findings suggest an antero-posterior translational and rotational instability of the distal fibula relative to the tibia [18]. In our opinion, one should not reason too far to appreciate quite striking similarities with the ACL-deficient knee. Can it be assumed in this comparison that the AITFL/IOL complex equals the ACL and the deltoid ligament (as a rotatory constraint) equals the eccentric anterolateral ligament (ALL)/Kaplan fibers in the ACL story? [8, 15, 18, 21].

Modern sports rehabilitation focusses on a holistic kinetic chain approach, taking into account neighboring joint and muscle groups. Is the causal factor to differentiate between a syndesmosis ankle and ACL knee injury, the position of the foot, the surface texture of the pitch, or is it the weight-bearing status of the injured limb or movement of the upper body? [1, 11, 13, 21] Additionally, assumptions are made in

✉ Thomas Tampere
Thomas.tampere@uzgent.be

[1] Department of Orthopaedic Surgery, Aspetar Orthopaedic and Sports Medicine Hospital, Sports City Street 1, Aspire Zone, PO Box 29222, Doha, Qatar

[2] Department of Orthopaedic Surgery, Ghent University Hospital, Corneel Heymanslaan 10, 9000 Ghent, Belgium

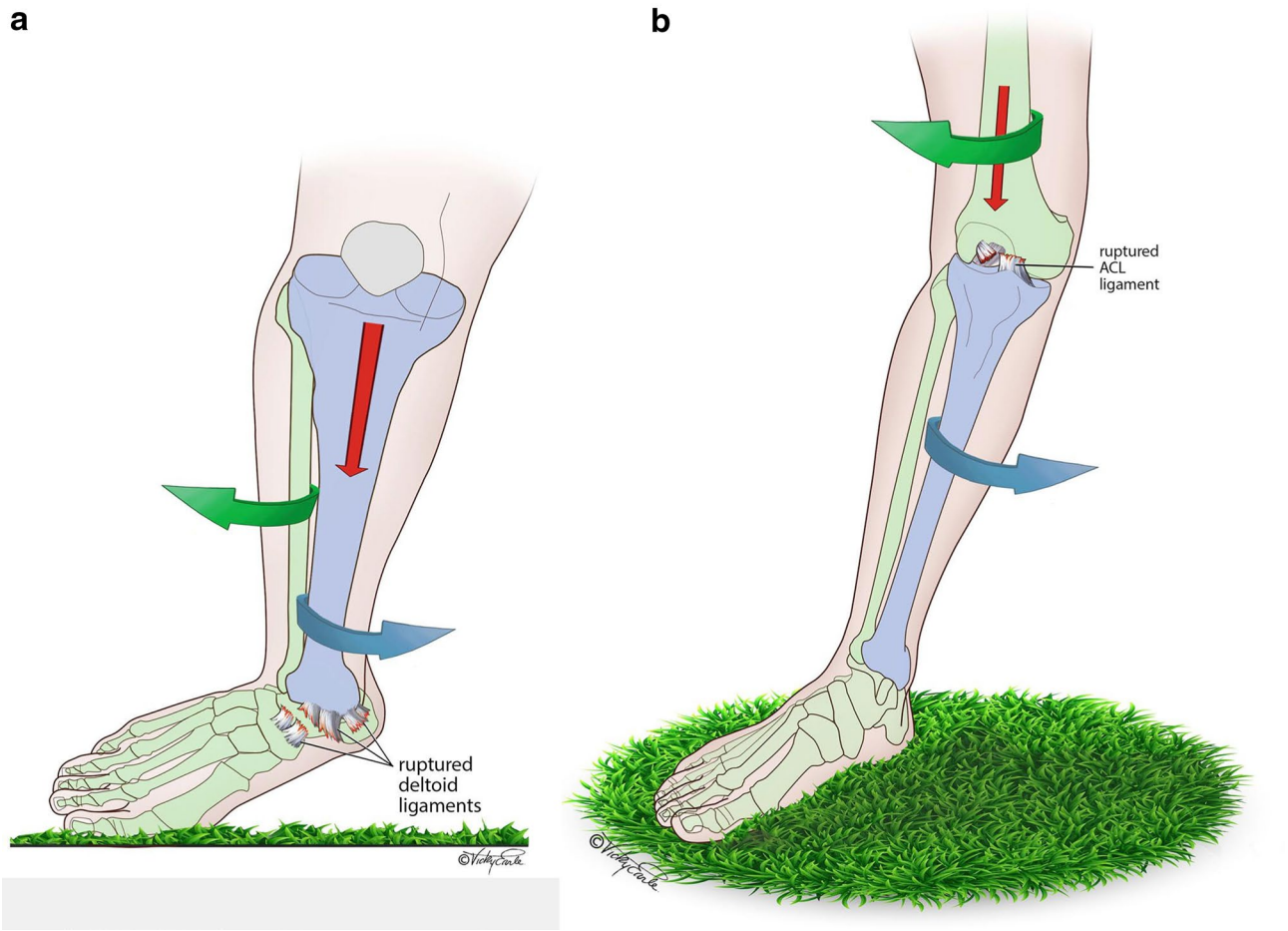

Fig. 1 **a** Mechanism of ankle syndesmosis injury. With the forefoot fixed in the grass and valgus/pronation of the hindfoot, the deltoid ligament ruptures. External rotation of the (for/mid) foot/talus/fibula complex causes rupture of the AITFL−IOL−(PITFL) (green + green arrow). Internal rotation of body and tibia (blue + blue arrow). Axial body load (red arrow). **b** Mechanism of ACL injury. Whole foot fixed in the grass. Valgus moment. External rotation of the femur and internal rotation of the tibia causing the postero-lateral bone bruise on the tibia (subluxation) (green and blue arrow). Axial load of body weight (red arrow)

the recent literature that a limited hip range of motion may alter ACL injury risk; looking down the chain of kinetics, one may wonder if there is a relation between the above-mentioned syndesmotic ankle and ACL knee injuries [2, 3, 25].

Diagnostics

The anterior drawer, and Lachman and pivot-shift tests are key clinical indicators in the diagnosis of an ACL knee rupture. These three clinical tests are helpful to evaluate antero-posterior and rotational instability in the ACL-deficient knee [14]. Similar to these tests, clinical examination of the ankle syndesmosis focusses on both types of instability by means of, respectively, the fibular translation test and the external rotation test, with the latter being the most sensitive, with the lowest false-positive test results [24, 27]. To our knowledge, no combined test is yet available to appreciate combined A-P and rotational ankle instability.

Magnetic resonance imaging (MRI) is the current modality of choice to visualize both the injured knee ACL as ankle syndesmosis ligament injuries. In acute ACL injuries, the femoral and postero-lateral tibial bone bruises are the pathognomonic signs of a sustained pivot-shift injury [7, 20, 23, 31]. Recent work of Randell et al. [22] revealed similar bone edema patterns in the posterior tibial plafond and talus, contributing to the suggested pivot-shift ankle mechanism concept. Quod erat demonstrandum?

Treatment and outcome

Recurrent ankle instability is known to ensue and eventually lead to premature ankle arthritis. In line, chronic ACL-deficient knees may lead to secondary cartilage/meniscal

damage and early onset osteoarthritis. Therefore, a timely diagnosis of unstable syndesmosis ankle and ACL knee injuries is essential. Until today, no predictive clinical knee or ankle tools are available to differentiate 'copers' from 'non copers' [12]. Bearing these consequences of chronic instability in mind, ACL knee reconstruction is the current treatment of choice in the active patient with reproducible and good-to-excellent results. With regard to surgical techniques, the past has proven that ACL repair failed on the mid and long term, with an ongoing search for suitable techniques. Treatment of choice remains reconstruction with lateral extra-articular tenodesis in case of significant rotational instability and pivoting sports [19]. Current techniques for treatment of ligamentous syndesmotic injuries are based on augmentation techniques to restore joint congruence and stability. Autologous ankle reconstruction techniques of the AITFL and/or IOL remain scarce without any evidence of superiority or added value [16].

Reflections

Reading the emerging literature on the high ankle sprain presents us with new insights but raises additional questions at the same time. When looking at the anatomy, biomechanics, diagnosis, and treatment of both and syndesmosis ankle injuries, the authors came across striking similarities. Whether identical entities, a continuum or separate injuries are faced; the aforementioned questions present a need for future biomechanical research on the potential link in pivot-shift injury of knee and ankle.

References

1. Balazs G, Pavey GN, Brelin A, Pickett A, Keblish D, Rue J (2015) Risk of anterior cruciate ligament injury in athletes on synthetic playing surfaces: a systematic review. Am J Sports Med 43(7):1798–1804
2. Beaulie M, Wojtys E, Ashton-Miller J (2015) Risk of anterior cruciate ligament fatigue failure is increased by limited internal femoral rotation during in vitro repeated pivot landings. Am J Sports Med 43(9):2233–2241
3. Bedi A, Warren R, Woitys E, Oh Y, Ashton-Miller J, Oltean H, Kelly B (2016) Restriction in hip internal rotation is associated with an increased risk of ACL injury. Knee Surg Sports Traumatol Arthrosc 24(6):2024–2031
4. Beumer A, Valstar E, Garling E, Niesing R, Ginai A et al (2006) Effects of ligament sectioning on the kinematics of the distal tibiofibular syndesmosis. Acta Orthop 77:531–540
5. Boytim M, Fischer D, Neumann L (1991) Syndesmotic ankle sprains. Am J Sports Med 19(3):294–298
6. Calder J, Bamford R, Petrie A, McCollum G (2016) Stable versus unstable grade II high ankle sprains: a prospective study predicting the need for surgical stabilization and time to return to sports. Arthroscopy 32:634–642
7. Chun D, Cho J, Min T, Park S, Kim K, Kim J, Won S (2019) Diagnostic Accuracy of radiologic methods for ankle syndesmosis injury: a systematic review and meta-analysis. J Clin Med. https://doi.org/10.3390/jcm8070968
8. Claes S, Vereecke E, Maes M, Victor J, Verdonk P, Bellemans J (2013) Anatomy of the anterolateral ligament of the knee. J Anat 223(4):321–328
9. D'Hooghe P, Alkhelaifi K, Abdelatif N, Kaux J (2018) From "low" to "high" athletic ankle sprains: a comprehensive review. Oper Tech Orthop 28(2):54–60
10. D'Hooghe P, Grassi A, Alkhelaifi K, Calder J, Baltes T, Zaffagnini S, Ekstrand J (2019) Return to play after surgery for isolated unstable syndesmotic ankle injuries (West Point grade IIB and III) in 110 male professional football players: a retrospective cohort study. Br J Sports Med. https://doi.org/10.1136/bjsports-2018-100298
11. Grassi A, Smiley S, Roberti di Sarsina T, Signorelli C, Marcheggiani Muccioli G, Bondi A, Romagnoli M, Agostini A, Zaffagnini S (2017) Mechanisms and situations of anterior cruciate ligament injuries in professional male soccer players: a YouTube-based video analysis. Eur J Orthop Surg Traumatol 27(7):967–981
12. Iliopoulos E et al (2017) Anterior cruciate ligament deficiency reduces walking economy in "copers" and "non-copers". Knee Surg Sports Traumatol Arthrosc 25(5):1403–1411
13. Kaeding C, Léger-St-Jean B, Magnussen R (2017) Epidemiology and diagnosis of anterior cruciate ligament injuries. Clin Sports Med 36(1):1–8
14. Lange T, Freiberg A, Dröge P, Lützner J, Schmitt J, Kopkow C (2015) The reliability of physical examination tests for the diagnosis of anterior cruciate ligament rupture—a systematic review. Man Ther 20(3):402–411
15. Lin C, Gross M, Weinhold P (2006) Ankle syndesmosis injuries: anatomy, biomechanics, mechanism of injury and clinical guidelines for diagnosis and intervention. J Orthop Sports Phys Ther 36(6):372–384
16. Liu G, Chen L, Gong M, Xing F, Xiang Z (2019) Clinical evidence for treatment of distal tibiofibular syndesmosis injury: a systematic review of clinical studies. J Foot Ankle Surg 58(6):1245–1250
17. Lubberts B, D'Hooghe P, Bengtsson H, DiGiovanni C, Calder J, Ekstrand J (2019) Epidemiology and return to play following isolated syndesmotic injuries of the ankle: a prospective cohort study of 3677 male professional footballers in the UEFA Elite Club Injury Study. Br J Sports Med 53(15):959–964
18. Lubberts B, Massri-Pugin J, Guss D, Wolf J, Bhimani R, Waryasz G, DiGiovanni C (2019) Arthroscopic assessment of syndesmotic instability in the sagittal plane in a cadaveric model. Foot Ankle Int. https://doi.org/10.1177/1071100719879673
19. Mathew M, Dhollander A, Getgood A (2018) Anterolateral ligament reconstruction or extra-articular tenodesis: why and when. Clin Sports Med 37(1):75–86
20. Musahl V, Karlsson J (2019) Anterior cruciate ligament tear. N Engl J Med 380(24):2341–2348
21. Peterson J, Krabak B (2014) Anterior cruciate ligament injury: mechanisms of injury and strategies for injury prevention. Phys Med Rehabil Clin N Am 25(4):813–828
22. Randell M, Marsland D, Ballard E, Forster B, Lutz M (2019) MRI for high ankle sprains with an unstable syndesmosis: posterior malleolus bone oedema is common and time to scan matters. Knee Surg Sports Traumatol Arthrosc 27(9):2890–2897
23. Roemer F, Jomaah N, Niu J, Almusa E, Roger B et al (2014) Ligamentous injuries and the risk of associated tissue damage in acute ankle sprains in athletes: a cross-sectional MRI study. Am J Sports Med 42:1549–1557
24. Van den Bekerom M (2011) Diagnosising syndesmotic instability in ankle fractures. World J Orthop 2:51–56

25. VandenBerg C, Crawford E, Sibilsky Enselman E, Robbins C, Woitys E, Bedi A (2017) Restricted hip rotation is correlated with an increased risk for anterior cruciate ligament injury. Arthroscopy 33(2):317–325
26. Van Dijk C, Longo U, Loppini M, Florio P, Maltese L, Ciuffreda M et al (2016) Conservative and surgical management of acute isolated syndesmotic injuries: ESSKA-AFAS consensus and guidelines. Knee Surg Sports Traumatol Arthrosc 24(4):1217–1227
27. Walls R, Ross K, Fraser E, Hodgkins C, Smyth N, Egan C, Calder J, Kennedy J (2016) Football injuries of the ankle: a review of injury mechanisms, diagnosis and management. World J Orthop 7(1):8–19
28. Watson B, Lucas D, Simpson G, Berlet G, Hyer C (2015) Arthroscopic evaluation of syndesmotic instability in a cadaveric model. Foot Ankle Int 36(11):1362–1368
29. Xenos J, Hopkinson W, Mulligan M, Olson E, Popovic N (1995) The tibiofibular syndesmosis: evaluation of the ligamentous structures, methods of fixation, and radiographic assessment. J Bone Jt Surg Am 77:847–856
30. Zalavras C, Thordarson D (2007) Ankle syndesmosis injury. J Am Acad Orthop Surg 15:330–339
31. Zhang L, Hacke J, Garrett W, Liu H, Yu B (2019) Bone Bruises associated with anterior cruciate ligament injury as indicators of injury mechanism: a systematic review. Sports Med 49(3):453–462