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MRI Diagnosis of Turf Toe Syndrome in A High-Level Athlete

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Abstract | **Case Report**

We report a case of severe turf toe injury with a complete medial plantar plate rupture and proximal retraction in a 31-year-old male judoka, diagnosed using magnetic resonance imaging. Patient presented with acute pain, swelling, and laxity of the first metatarsophalangeal joint following a traumatic hyperextension injury. Xray radiographs were obtained but did not show any osseous injury or significant malalignment. MRI findings revealed a complete rupture of the medial plantar plate with proximal retraction, bone marrow edema in the first metatarsal head, and associated capsuloligamentous injury, consistent with a Grade 3 turf toe injury (Thevendran *et al.,* 2021). This case underscores the critical role of advanced imaging in delineating the extent of soft tissue and osseous lesions for optimal management of complex sports-related foot injuries.

Keywords: Turf toe, plantar plate rupture, magnetic resonance imaging, athletic injury, metatarsophalangeal joint.

INTRODUCTION

Injuries to the first metatarsophalangeal joint, commonly known as "turf toe," represent a spectrum of sprains to the plantar capsuloligamentous complex of the great toe (Tewes *et al.,* 1994). These injuries, particularly prevalent in athletes participating in sports on artificial surfaces, arise from excessive dorsiflexion or hyperextension mechanisms(Rodeo *et al.,* 1990). The severity of turf toe can range from mild sprains to complete disruption of the plantar plate and associated structures(Thevendran *et al.,* 2021). Magnetic resonance imaging is a crucial diagnostic tool for evaluating the extent of these injuries, offering detailed visualization of soft tissue and osseous involvement (Filippi *et al.,* 2020; Gyftopoulos & Woertler, 2021).

CASE PRESENTATION

A 31-year-old male competitive judoka, measuring 204 cm in height and weighing 131 kg, presented after an acute sports-related injury involving the great toe. He described sudden severe pain at the base of the hallux during exertion, followed immediately by functional impairment. Clinical examination revealed marked tenderness and swelling centered on the first metatarsophalangeal (MTP) joint, with abnormal laxity raising suspicion for a significant capsuloligamentous injury. The mechanism was consistent with a hyperextension injury of the first MTP joint, suggestive of turf toe syndrome. Initial radiographs were obtained to exclude fracture or dislocation, but showed no overt osseous abnormality or significant joint malalignment, prompting further evaluation with magnetic resonance imaging.

MRI of the forefoot demonstrated a complete disruption of the medial plantar capsuloligamentous structures of the first MTP joint. On the axial T1-weighted image (figure 1, a), there was loss of the normal low-signal continuity of the medial plantar plate, associated with proximal displacement of the medial sesamoid. Dorsoplantar fat-suppressed images confirmed a complete tear of the medial aspect of the plantar plate, seen as a fluid-signal cleft replacing the normally low-signal ligamentous fibers, with proximal retraction of the torn plantar plate (figure 1, b, c and d). Associated findings included surrounding soft-tissue edema and bone marrow edema centered on the first MTP joint, predominantly involving the head of the first metatarsal. These imaging features were consistent with a severe plantar capsuloligamentous injury of the first MTP joint, corresponding to grade 3 turf toe syndrome. In view of the patient's athletic profile, the degree of clinical laxity, and the MRI evidence of complete plantar plate rupture with retraction, the lesion was considered a high-grade injury with important implications for joint stability and return to sport.

Conservative management was initially considered; however, given the patient's high-level

athletic activity, the marked clinical instability, and the MRI findings of complete rupture of the medial plantar plate with proximal retraction, surgical treatment was favored. The patient subsequently underwent operative repair of the plantar capsuloligamentous complex. Postoperative immobilization and a structured rehabilitation program were instituted, with the aim of restoring first MTP joint stability, preserving push-off function, and enabling a safe return to competitive sport.

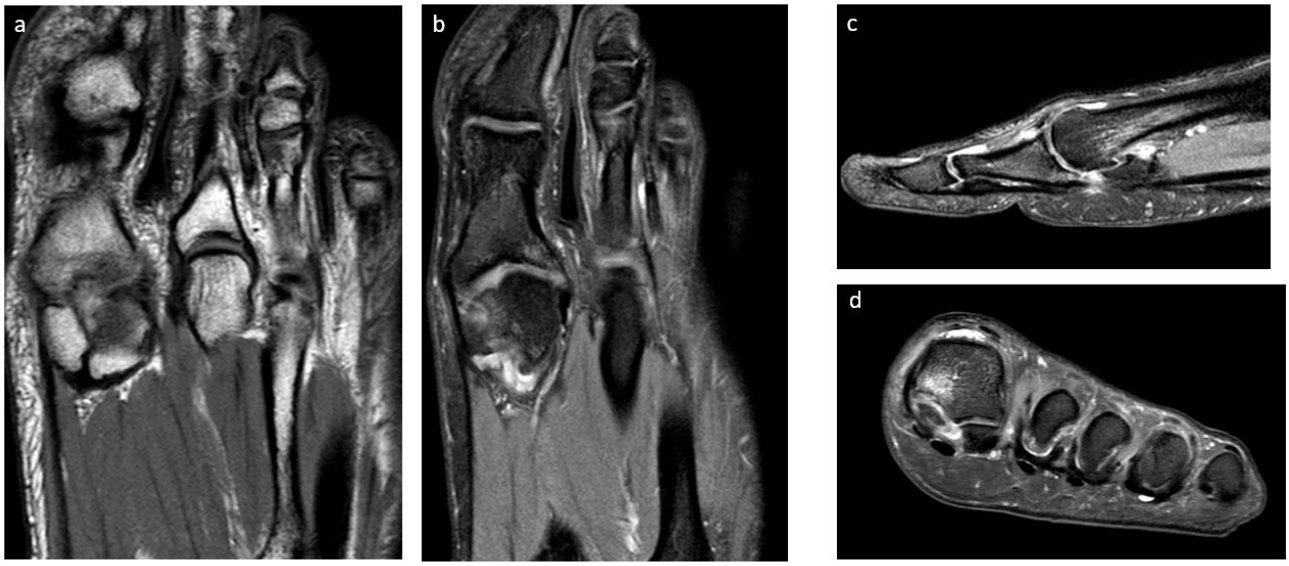

Figure 1: Axial T1-weighted image (a) shows loss of normal continuity of the medial plantar plate at the first metatarsophalangeal joint, associated with proximal migration of the medial sesamoid. DP fat-suppressed images (b–d) better depict the full-thickness tear of the medial plantar plate as a hyperintense fluid gap with proximal retraction of the torn fibers, associated with adjacent soft-tissue edema and marrow edema of the first metatarsal head, in keeping with a grade 3 turf toe injury

DISCUSSION

Anatomy and Biomechanics of the First Metatarsophalangeal Joint

The first metatarsophalangeal joint is a critical structure for propulsion and weight-bearing, stabilized by a complex arrangement of static and dynamic elements. Its intricate capsuloligamentous complex, including the plantar plate, collateral ligaments, and sesamoid apparatus, plays a pivotal role in maintaining joint integrity and function (Hallinan *et al.,* 2020; Jine *et al.,* 2021). The plantar plate, a fibrocartilaginous structure originating from the metatarsal neck and inserting at the plantar aspect of the proximal phalanx, is the most frequently injured component (Meyer *et al.,* 2018; Reijnierse & Griffith, 2023). This structure, along with the medial and lateral collateral ligaments, forms a critical three-sided box that resists hyperextension and varus/valgus stresses at the MTP joint.

Mechanism and Grading of Turf Toe Injuries

Turf toe injuries typically result from an acute traumatic hyperextension or hyperflexion of the first MTP joint, often occurring when the heel is elevated and the toes are fixed on the ground(McCormick & Anderson, 2010; Poppe *et al.,* 2019). This mechanism, frequently observed in contact sports, can lead to a spectrum of injuries, from minor sprains to complete disruption of the plantar plate and associated structures (Limaye *et al.,* 2024). These injuries are systematically graded based on the extent of structural damage to the plantar plate complex, which directly influences management strategies and prognostic outlook (Winters & Raikin, 2018). Grade 1 injuries involve a stretch of the plantar complex, Grade 2 a partial tear, and Grade 3 a complete rupture of the plantar plate(Thevendran *et al.,* 2021).

Magnetic Resonance Imaging in Turf Toe Diagnosis

MRI is particularly valuable for its ability to non-invasively assess soft tissue structures, providing superior contrast resolution compared to other imaging modalities for detecting subtle edema, tears, and displacement within the plantar plate complex (Gorbachova, 2020). It offers detailed visualization of osseous involvement, such as bone marrow edema, and aids in identifying associated capsuloligamentous injuries that may not be apparent on conventional radiographs (McCormick & Anderson, 2010). This diagnostic capability is paramount for accurately characterizing severe turf toe injuries and differentiating them from other forefoot pathologies (Gorbachova, 2015). Specifically, MRI can accurately demonstrate the integrity of the plantar plate, sesamoids, and collateral ligaments, crucial for guiding clinical decision-making(Gorbachova, 2020; Miranda *et al.,* 2021).

Differential Diagnoses

Given the nonspecific nature of forefoot pain, it is crucial to differentiate turf toe injuries from other pathologies presenting with similar clinical manifestations, such as sesamoiditis, gout, hallux rigidus, and Freiberg's infraction. Distinguishing between these conditions often necessitates a comprehensive clinical evaluation coupled with advanced imaging, such as MRI, to precisely identify the underlying pathology(Ashman *et al.,* 2001). For instance, differentiation from other causes of forefoot pain, such as metatarsalgia from stress fractures or degenerative arthritis, is critical for appropriate management (Ashman *et al.,* 2001).

Prognostic and Therapeutic Implications

The precise characterization of turf toe injuries, particularly severe forms with complete plantar plate rupture and retraction, has significant implications for both prognosis and guiding therapeutic interventions (Anderson, 2002). Early and accurate diagnosis via MRI allows for individualized treatment plans that can prevent long-term complications and facilitate a successful return to play for athletes (Chiou *et al.,* 2019).

CONCLUSION

This case report highlights the critical role of MRI in the definitive diagnosis of severe Grade 3 turf toe injuries, particularly in high-performance athletes where precise anatomical assessment dictates management strategies and prognostic outcomes. The detailed visualization of plantar plate integrity, associated capsuloligamentous injury, and bone marrow edema afforded by MRI is indispensable for evaluating injury severity and informing treatment pathways (Duan *et al.,* 2017; Waldrop *et al.,* 2013; Yao *et al.,* 1996). This comprehensive imaging approach ensures optimal functional recovery and mitigates the risk of chronic instability or degenerative changes in the first MTP joint, which are pertinent concerns for professional athletes (Najefi *et al.,* 2018).

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