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Review

Time for a paradigm shift in the classification of muscle injuries

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Abstract

Muscle injuries remain one of the most common injuries in sport, yet despite this, there is little consensus on how to either effectively describe or determine the prognosis of a specific muscle injury. Numerous approaches to muscle classification and grading of medicine have been applied over the last century, but over the last decade the limitations of historic approaches have been recognized. As a consequence, in the past 10 years, clinical research groups have begun to question the historic approaches and reconsider the way muscle injuries are classified and described. Using a narrative approach, this manuscript describes several of the most recent attempts to classify and grade muscle injuries and highlights the relative strengths and weaknesses of each system. While each of the new classification and grading systems have strengths, there remains little consensus on a system that is both comprehensive and evidence based. Few of the currently identified features within the grading systems have relevance to accurately determining prognosis.

Keywords: Classification; Grading; Magnetic resonance imaging; Muscle injury; Return to play; Ultrasound

1. Introduction

Muscle injury remains one of the most common injuries in sport and of the muscle groups, the hamstrings are the most frequently injured.[1–6] In sports medicine, the ability to accurately diagnose, manage, and prognosticate, are routine expectations of practitioners. While numerous muscle injury classification and grading systems exist, there remains limited evidence or consensus on how to either describe a specific muscle injury, or determine the prognosis of any given injury, and this remains a frustration for both the clinician and the athlete.[7]

Injury "classification" refers to the process of describing or categorizing an injury (such as by its location, mechanism, or underlying pathology), while a "grade" provides an indication of severity.[7] While from the perspective of athletes and coaches the most relevant measure of injury severity is the length of time taken to return to full sports participation, severity may also be determined by symptoms, signs, and imaging findings. While the ability to predict return to play (RTP) is an expectation placed upon practitioners working with athletes, there is still incomplete evidence upon which to base decisions.[8–12]

In 1966, the American Medical Association (AMA) published a clinical grading system for muscle injuries as a means for determining injury severity.[13] Despite lacking an evidence base, the categorical grading approach of the AMA has remained popular and until recently largely unchanged in mainstream medical literature (Table 1).

More recently, specific clinical features such as the nature of pain onset, localised tenderness, pain severity, time to walk pain free, active range of motion of the knee and playing position in football, have all been identified as potential predictors of hamstring muscle injury severity, although the findings have been inconsistent, unreplicated, and often with limited relevance across all athletic levels of play.[14–24] For example, while time to walk pain free may be associated with either an early (less than 40 days) or late (greater than 40 days) RTP,[25] this duration is perhaps irrelevant in elite or competitive sport where a much more detailed prognosis is required, and where time for RTP may be expected to be significantly less.[26]

The availability of magnetic resonance imaging (MRI) and ultrasound (US) imaging in the 1990s allowed for the

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Table 1
Typical 1960-era muscle injury classification (based upon the American Medicine Association system for muscle injury classification).[13]

Degree of injury	Definition
First degree strain (also known as mild strain; slightly pulled muscle)	Trauma to musculotendinous unit due to excessive force or stretch. Localized pain, aggravated by movement; minor disability; mild swelling, ecchymosis, local tenderness; minor disability. Tendency to recur. Minimal hemorrhage, inflammation mainly, some disruption of musculotendinous tissue.
Second degree strain (also known as moderate strain; moderately pulled muscle)	Trauma to musculotendinous unit due to violent contraction or excessive forced stretch. Localized pain, aggravated by movement; moderate disability; moderate swelling, ecchymosis, and local tenderness. Stretching and tearing of fibers, without complete disruption; tendency to recur; aggravation.
Third degree strain (also known as severe strain; severely pulled muscle)	Trauma to musculotendinous unit due to violent contraction or excessive forced stretch. Severe pain and disability; severe swelling, ecchymosis, hematoma, palpable defect, and loss of muscle function. Muscle or tendon rupture, including musculotendon junction or avulsion with bone.

visualisation of underlying detail of muscle pathology, previously only speculated upon through clinical assessment. Radiologists could quickly correlate clinical findings with imaging characteristics and established early categorical radiological grading systems.[27–30] However, the initial literature was limited by small sample sizes and constrained by the clinical muscle injury grading paradigm established in the pre-imaging era. Typically the imaging systems lacked any data supporting a relationship between imaging appearance and prognosis.[29–31]

More recently, researchers have attempted to correlate categorical MRI grading systems[27,28] with clinical outcome.[9,32] Using a large cohort of professional footballers, Ekstrand et al.[9] observed that Grade 0 (MRI negative for any observable abnormality) had a significantly better prognosis than all other grades of injury, corroborating the findings of previous authors.[18,19,22,23,33,34] Later work from the same research group found a statistically significant difference in clinical outcome between MRI determined Grades 1 and 2 muscle injury, with the authors concluding that traditional image-based categorical grading has prognostic validity.[32] However, while statistically significant differences in RTP duration were documented, the wide variance observed in this measure likely limits the clinical utility of this approach, particularly in those settings where accurate prognostication is typically demanded by coaches and athletes.[35]

The early 21st century has seen increased cohort sizes utilised to evaluate the prognostic validity of both clinical and imaging observations. Typically estimated from MRI, injury length, cross-sectional area, and estimated volume of muscle injury have all been proposed as indicators of hamstring injury severity with larger lesions requiring a longer rehabilitation period.[18,19,21,22,24] Recently, a single study has highlighted that over and above any of the previously described radiological features, damage to the intra-muscular tendon may be the single most relevant predictor of RTP duration.[8] However, limitations in the design of the majority of MRI-based studies, including a high risk of bias,[36] means that many of these proposed prognostic indicators require further validation.

In recent years, there has been increasing attention and effort directed at developing a standardized and practical muscle injury classification and grading system. The purpose of this study was to review the recently proposed muscle injury classification and grading systems to identify areas of commonality and difference with the intent of identifying key gaps in our current knowledge. Specifically, attention will be paid to the recently proposed Munich consensus,[37] British athletics,[38] and FC Barcelona[39] classifications, as well as 2 additional novel radiological classifications.[40,41]

2. Modern muscle injury classification systems

2.1. Munich consensus system

The Munich consensus statement resulted from a 1-day meeting of international clinical and basic science experts.[37] Based on the experience of the attendees, and the results of 19 completed pre-meeting questionnaires, the authors described a comprehensive classification and grading system for muscle injury.

The classification initially distinguishes direct (contusion and laceration) from indirect muscle injury. Indirect muscle injuries are then classified as either functional or structural injuries, sub-classified further into a type of injury, and finally sub classified into either a diagnostic group (e.g., fatigue induced muscle disorder; delayed onset muscle soreness (DOMS); or muscle or spine related neuromuscular disorder) or severity grade (minor partial, moderate, subtotal, complete, or avulsion). Each classification or grade is provided with a definition, as well as classical symptoms, signs, and imaging findings. A validation study confirmed that structural injuries (largely determined by those that are MRI positive for muscle damage) have a greater time loss than functional injuries, and that moderate and sub or total injuries have a worse prognosis than minor partial muscle tears.[42]

The Munich consensus approach addresses muscle injury in a comprehensive manner, which includes the incorporation of acute, overuse, direct, and indirect injury descriptors. In this regard, the Munich consensus may be considered a highly comprehensive approach to the study of muscle injury.

Underlying the construction of this classification and grading system are principles and assumptions that are not universally accepted. For example, the use of the term functional in this classification has a specific meaning, quite distinct to its use in other areas of medicine and as a result its application remains challenging to traditionally conservative practitioners.[43] While the use of the term “functional injuries” may be clinically appealing, there remains only limited academic