REVIEW OPEN ACCESS

Medical retirement from sport after concussions

A practical guide for a difficult discussion

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Abstract

Purpose of review

In patients with a considerable history of sports-related concussion, the decision of when to discontinue participation in sports due to medical concerns including neurologic disorders has potentially life-altering consequences, especially for young athletes, and merits a comprehensive evaluation involving nuanced discussion. Few resources exist to aid the sports medicine provider.

Recent findings

In this narrative review, we describe 10 prototypical vignettes based upon the authors' collective experience in concussion management and propose an algorithm to help clinicians navigate retirement discussions. Issues for consideration include absolute and relative contraindications to return to sport, ranging from clinical or radiographic evidence of lasting neurologic injury to prolonged concussion recovery periods or reduced injury threshold to patient-centered factors including personal identity through sport, financial motivations, and navigating uncertainty in the context of long-term risks.

Summary

The authors propose a novel treatment algorithm based on real patient cases to guide medical retirement decisions after concussion in sport.

Use these points to inform discussion of potential retirement

1. Is contact/collision an unavoidable part of patient's sport?
2. Is theoretical risk of future concussion/prolonged postconcussion symptom period acceptable?
3. Willing to balance future career aspirations with potential risk of long-term cognitive impairment?
4. Identity as an athlete?
5. Financial incentives/athletic goals?
6. Concern for or family history of neurodegenerative disease?

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Sports-related concussion (SRC) is an important public health problem potentially affecting millions of American youth annually.[1] Heightened public awareness of SRC[2] has coincided with a growing epidemiologic research field[1] and improved understanding of concussion pathophysiology,[3] but challenges persist in determining individualized risk profiles for recurrent SRC[4,5] and long-term neurologic and behavioral outcomes[6] in contact and collision sport athletes. Involuntary termination of a sports career due to injury has potentially life-altering academic, psychosocial, and athletic consequences,[7] and can be particularly relevant to athletes with complicated SRC histories.

Well-established guidelines exist for return to play (the first step in return to sport [RTS])[8] and academic return to learn[9] following SRC, and some guidance has been developed to help

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athletes cope with transitions out of sports careers.[10] However, no known guidelines currently exist to inform clinicians how to suggest or consider medical retirement (also known as medical disqualification) specifically following SRC. Absolute and relative contraindications to future play have been proposed,[11-14] and can inform a retirement discussion involving the athlete, his or her family, and sports medicine providers. In reality, access to experts in concussion care and application of concussion care strategies remains challenging and variable across communities.[15] We sought to create a clinical decision tool in the form of an SRC retirement algorithm based on our group's experience managing youth, collegiate, professional, and adult athletes, using data-driven decisions whenever possible, and providing guidance in practically navigating inherent uncertainty.

Methods

To create this decision algorithm and related vignettes, we drew from our group's experience treating thousands of SRC patients, ranging from youth to professional athletes, and specifically considered 22 recent cases to identify clinical considerations and patient-centered factors leading to retirement or alternatively RTS. Case records were drawn from patients seen by the physician coauthors in a suburban sports medicine practice, an urban collegiate sports medicine program, and a behavioral neurology practice. Records were selected, de-identified, and condensed down to 10 vignettes highlighting specific, recurring, and common themes identified in practice, which informed the development of an empiric, practice-based algorithm. The Columbia University Medical Center institutional review board approved the study.

Illustrative case series

Case 1: A lifetime of traumatic brain injury exposure

A 21-year-old collegiate basketball player with 6 SRCs since age 8 presents after a recent SRC complicated by prolonged recovery. After 5 months, she returns to a full academic load and considers returning to basketball. Since her last concussion, lifelong migraines have become more frequent, independent of exertion, and are medically refractory. She has played basketball since age 7 and her personal identity and social networks are strongly tied to her sport. However, personal academic goals and concern for her risk of recurrent concussion and another prolonged recovery period[4,5] drive her to voluntarily retire from sport.

Case 2: Differing physician and player concerns

A 21-year-old collegiate football lineman recently sustained his third SRC. Review of his concussion history reveals a prolonged recovery period after his first high school SRC. His 2 most recent concussions occurred a month apart, both during routine contact and required academic accommodations. Brain MRI revealed a small middle fossa arachnoid cyst, which carries a low risk of subdural hematoma.[16-19] The physician introduces consideration of retirement due to the player's susceptibility to concussion during routine sport-specific contact, not the presumably congenital MRI finding. The player decides to retire, but cites concern for his minor MRI abnormality as his main driving factor.

Case 3: Elite athletic aspirations despite concerning SRC history

A 22-year-old collegiate field hockey player with a complicated SRC history presents in anticipation of participating on the national team. Her seventh, and most recent, concussion led to withdrawal from a collegiate semester's coursework, but symptoms resolved months later, at which time she begins to consider retirement vs RTS. She expresses understanding of the potential immediate and long-term consequences of recurrent SRC including longer recovery periods or permanent sequelae,[20] but is willing to accept these risks in hopes to compete in the Olympic Games as a career-culminating experience.

Case 4: Discussing retirement as part of routine SRC care

A 19-year-old collegiate lacrosse player with a history of infrequent migraines and multiple SRCs beginning in early childhood presents with persistent postconcussive symptoms lasting 1 month following a high-velocity direct ball-to-head contact. Following recovery, given her SRC history, retirement was briefly discussed but RTS was considered safe given that her recent SRCs required substantial and atypical contact for her sport, without apparent decreased threshold or prolonged recovery.[11]

Case 5: Comorbid mood disorder and elective retirement

An 18-year-old wrestler presents after his third SRC 18 months ago. His initial course suggested postconcussion symptoms for 1 month, which resolved fully but were followed by recurrent depressive episodes. He received psychiatric care and responded well to psychotropics and counseling. He laments his slow recovery and its effect on returning to sports. Upon returning to wrestling, he noted minor practice head contact led to recurrence of prior symptoms. While he identifies strongly as a wrestler, with the help of the provider, he reflects on his current and future neurobehavioral health,[20,21] and voluntarily retires to focus on college academics.

Case 6: Ending a sports career following SRC with concerning features

A 22-year-old college senior football player experienced his first 2 SRCs of his lifetime early in the prior season, which interrupted his participation in his final year of collegiate football. His second SRC was associated with brief loss of consciousness (LOC) and fencing posture, although recovery was otherwise normal. He weighs returning for a fifth year of football for personal motivations. Given the close

timing of 2 successive concussions in one season and his concussive convulsion,[22,23] retirement is advised.

Case 7: Clear MRI evidence of prior traumatic brain injury

A 28-year-old professional fighter with multiple SRCs is referred to a specialist for evaluation of an unexpected finding on high-field MRI brain performed for research. Findings included frontotemporal gliosis and microhemorrhages in the left centrum semiovale and right anterior corpus callosum, indicating substantial traumatic brain injury (TBI) history. Given high risk for long-term sequelae,[24] retirement from combat sports or contact sports with high risk for contact and collision is advised.[19]

Case 8: Suggesting a replacement for contact sports

A 16-year-old high school soccer player with a medical history of short stature presents seeking medical clearance after his third SRC. Each successive injury has been associated with increasing recovery duration. Given the high risk of future contact in his sport, and his increasingly outmatched size, at the prior visit the provider asked the patient to consider retirement from contact sports, particularly soccer, and reviewed activities including noncontact sports to replace the athletic, competitive, and social voids created by a retirement from soccer. The patient and his family ultimately decide to return to soccer and he is provided medical clearance to do so, but shortly into the season he experiences a ligamentous knee injury and misses the remainder of the season rehabilitating.

Case 9: Poor recognition and reporting of SRCs

An 18-year-old high school ice hockey forward with a college athletic scholarship and a history of 3 SRCs presents for evaluation of persistent headaches after a tournament. She divulges that throughout her athletic career she has experienced exertional headaches and played through them despite awareness of risks of underreporting SRC.[25,26] After following appropriate RTS protocol over many months, including stepwise return to noncontact activity, academics, and eventually full-contact collegiate hockey, she subsequently has a new SRC. This injury prompts both physician and athlete to agree on retirement from contact sports due to her SRC history, including frequent unrecognized SRCs coupled with increasing recovery periods and risk of long-term adverse neurologic outcomes secondary to frequent and unreported SRCs.

Case 10: Sports as a livelihood

A 26-year-old professional football player with 4 SRCs and a family history of amyotrophic lateral sclerosis (ALS) in a parent presents after 2 SRCs in 6 weeks. He recovered rapidly from the first concussion, but experienced 2 months of postconcussion symptoms after the second. Although fully recovered by the time of his visit, a more cautious approach is recommended given the short interval between recent concussions and long duration of symptoms. The player's concerns include his fears of losing his position and livelihood if absent from play for an extended period, vs the risks of future concussion, especially given his family history of neurodegenerative disease. Acknowledging long-term neurologic sequelae associated with football, including uncertain risks for neurodegenerative diseases like ALS,[20] the patient's professional motivations compelled him to RTS, and no subsequent head injuries were sustained during 2-year follow-up.

> The decision to retire a player often rests on a combination of many relative factors, which lack evidence-based support and can be difficult to navigate.

SRC retirement algorithm

Figure 1 summarizes current RTS guidelines, which adequately treat the vast majority of concussion patients, who experience a full recovery on the order of days to weeks, as well as the minority with post-SRC symptoms lasting weeks to months. The proposed Columbia SRC Retirement Algorithm shown in figure 2 guides the discussion of retirement (or disqualification) of a small fraction of concussion patients with concerning neurologic features, and broadly consists of 3 main decision points: (1) absolute contraindications to RTS, (2) relative contraindications to RTS, and (3) patient-centered factors guiding discussion.

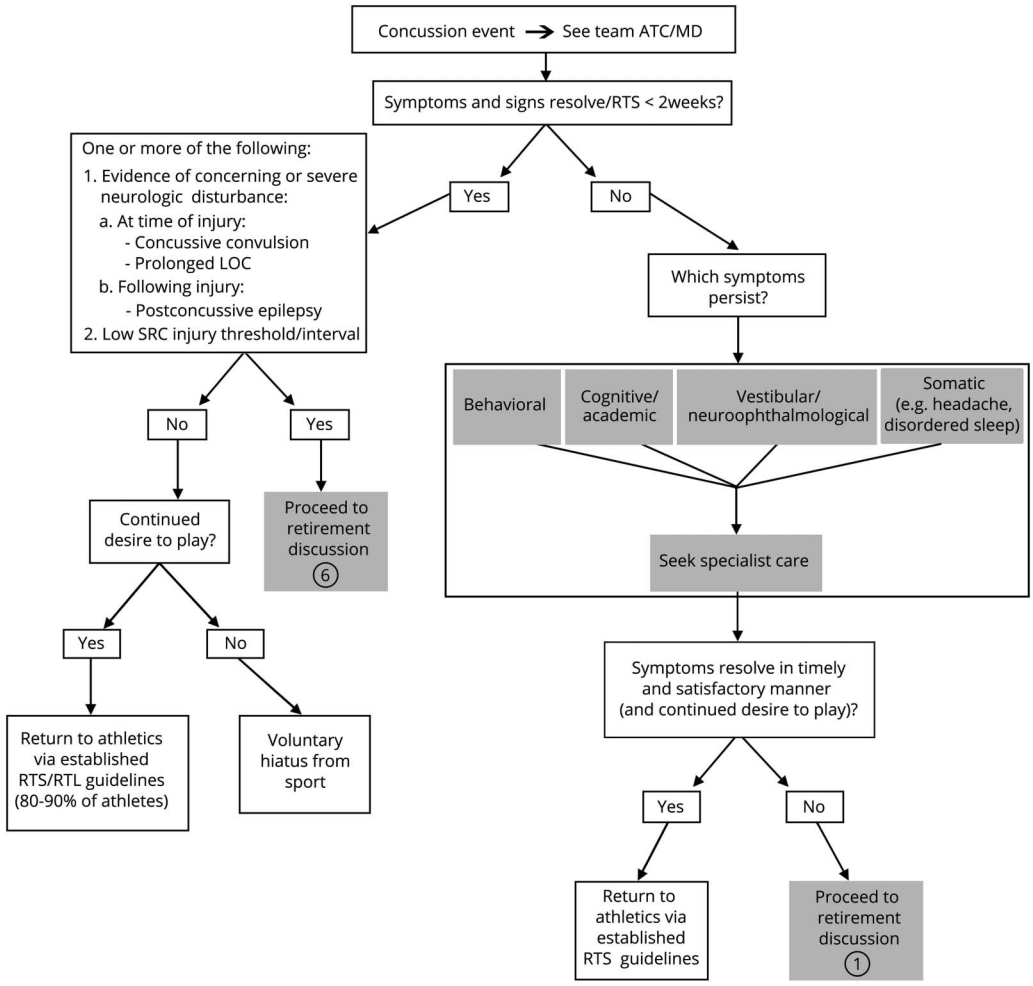
Absolute contraindications to RTS

The first branch point in figure 2 demonstrates absolute contraindications to RTS: (1) evidence of structural brain injury pathognomonic of recent or remote TBI identified clinically or on routine neuroimaging, such as frontotemporal contusions or gliosis[27,28] (case 7); or (2) structural abnormalities not likely due to TBI but associated with increased risk of subsequent intracranial hemorrhage should future head contact occur.[19] Coincidental brain imaging abnormalities are common in young persons, with prevalence of approximately 10%.[29,30] In many circumstances, a structural imaging abnormality unrelated to TBI may be treated as a part of a patient's history rather than an absolute contraindication to RTS (case 2). Some structural brain abnormalities may warrant neurosurgical consultation.[31]

Relative contraindications to RTS

When considering patients with persistent symptoms after SRC, it is important to identify and treat disorders coexistent with but not necessarily due to TBI, including mood disorder, benign paroxysmal positional vertigo, and migraine, among other conditions (cases 1 and 4).[8] As previously described,[11-13] relative contraindications to RTS include a history of (1)

Figure 1 Considerations for concussed athletes leading to medical care or return to sport (RTS)

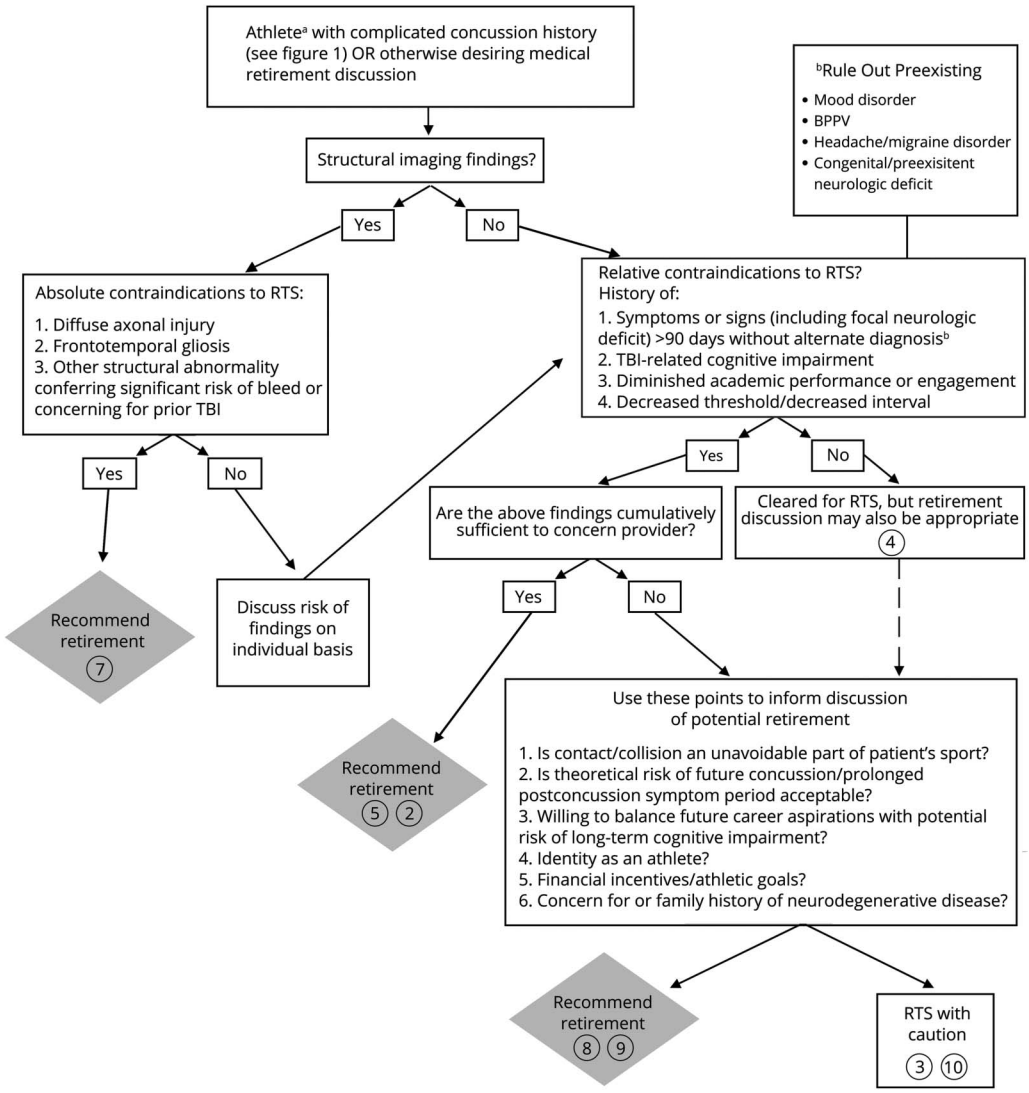


The circled numbers included in the boxes at many of the endpoints correspond to the patient case numbers described in the prior section. LOC = loss of consciousness; RTL = return to learn; SRC = sports-related concussion.

postconcussive signs or symptoms that are ongoing at the time of evaluation or lasting more than 90 days, or increasing in severity with each successive concussion, (2) cognitive impairment (as demonstrated on neuropsychological testing), (3) diminished academic performance or social engagement, and (4) decreased concussion threshold or decreased interval between concussions. Patients with a history of one or more relative contraindications can still be safely returned to play with appropriate guidance and follow-up (cases 3 and 10).[32] Several coexistent relative contraindications can lead to a recommendation of retirement (cases 2, 5, 8, and 9). The algorithm favors the circumstances of each SRC, particularly the most recent one, rather than absolute SRC count.

Aside from LOC, various acute neurologic signs may be observed immediately following SRC, and deserve specific consideration in retirement discussions given their obvious and arguably worrisome features. These include (1) "immediate epilepsy" or "impact seizures," which can manifest as generalized tonic-clonic seizures,[33] (2) "concussive convulsions" (including fencing and other tonic postures),[34,35] and (3) other signs suggesting disturbance in neurologic function due to sudden and substantial mechanical forces affecting cortical or subcortical structures. Mild TBI is associated with incident posttraumatic epilepsy but is uncommon even following LOC or impact seizures.[36] Like seizures, concussive convulsions (case 6) are thought to have a benign prognosis, but data on long-term outcomes are limited to small case series.[34,35] Behavioral changes following SRC are well-recognized[37] and although rare, our group has also cared for patients with brief episodes of uncontrollable laughter and crying with preservation of consciousness immediately following SRC impact. It is uncertain if these specific events should be considered in a spectrum of adult nonhamartomatous gelastic or dacrystic seizures.[38] How to weigh the importance of immediate, transient, and obvious signs of neurologic dysfunction following impact remains especially challenging. Research has typically focused on competitive level in sport and concussion exposure history

Figure 2 Provider decision algorithm: Considerations in retirement discussion and recommendation



The circled numbers included in the boxes at many of the endpoints correspond to the patient case numbers described in the prior section. [a]Ideally, athlete is asymptomatic at time of discussion. [b]Reference the "Rule out preexisting" box located at the top right of the figure. BPPV = benign paroxysmal positional vertigo; RTS = return to sport; TBI = traumatic brain injury.

rather than on specific signs, such as seizure activity, as a risk factor for early-onset cognitive impairment.[20] Without specific evidence from epidemiologic studies to the contrary, we argue that signs of SRC-related convulsive activity should be regarded as a relative contraindication for RTS and at minimum prompt a discussion of retirement.

Patient-centered factors in retirement

The final step in our algorithm outlines questions and topics that are crucial to introduce with each patient to ensure that the provider understands all medical, emotional, and professional considerations relevant to an individual's retirement decision. The nature of the medical retirement conversation will differ substantially depending on each patient's age, medical history, family neurologic history, level of sport, and amount of expected future contact and collision, plus other nonmedical factors including personal identity as an athlete and financial incentives (e.g., professional status or collegiate scholarship), or personal athletic goals. The table summarizes major decision points relating to each of the 10 illustrative cases of athletes being considered for medical retirement following SRC.

Discussion

The majority (70%–90%) of concussed athletes recover quickly (in 10–14 days)[8,39] and therefore need not have a discussion about ending sports participation. In contrast, providers should consider medical disqualification in athletes with more extensive or complicated concussion history. The decision to retire a player often rests on a combination of

Table Key decision points for each of 10 athletes being considered for medical retirement following concussion

Case no.	Title	Severe neurologic disturbance	Lowered injury threshold	Decreased injury interval	Imaging findings	History of symptoms >90 days	Cognitive impairment or academic accommodations	Professional motivations
1	A lifetime of TBI exposure				+	+	+	
2	Differing physician and player concerns	+	+	+				
3	Elite athletic aspirations despite concerning SRC history					+		+
4	Discussing retirement as part of routine SRC care				+	+	+	
5	Comorbid mood disorder and elective retirement	+	+					
6	Ending a sports career following SRC with concerning features	+		+				
7	Clear MRI evidence of prior TBI				+			+
8	Finding a replacement for contact sports					+		
9	Poor recognition and reporting of SRCs		+			+		
10	Sports as a livelihood			+		+		+

Abbreviations: SRC = sports-related concussion; TBI = traumatic brain injury.
Case numbers correspond to vignettes in text, as well as decision tree in the figure. + Indicates a prominent factor in consideration of medical retirement following SRC.

many relative factors, which lack evidence-based support and can be difficult to navigate. Until clearly defined, data-driven decisions can be made, an empiric algorithm such as the Columbia SRC Retirement Algorithm proposed here can help guide retirement decisions. These 10 illustrative vignettes of high-risk athletes cover a wide range of ages, sports, and competitive levels, and highlight key points in conducting a retirement discussion, even in the absence of an absolute contraindication to RTS.

Although not always possible, a retirement discussion should ideally take place when the patient is fully recovered. The discussion should follow a detailed medical and sports history, concussion symptom inventory, neurologic examination, imaging and neuropsychological testing when indicated, and a deep exploration of the social factors and motivations related to the patient's continuing participation. Such an approach can identify unrecognized or undisclosed SRCs (case 9), which may affect the substance of a retirement discussion and provide an opportunity for concussion education (case 4). Providers should ensure that such discussions are documented in the patient's medical record.

Providers must help athletes assess whether they are willing to accept uncertain future risk of both another prolonged recovery and of future cognitive impairment.

In many cases, an SRC-focused retirement discussion involves weighing what is known about short- and long-term brain health[20] against the patient-centered factors described above. Providers must help athletes assess whether they are willing to accept uncertain future risk of both another prolonged recovery and of future cognitive impairment, especially in light of the current knowledge limitations concerning the exact neurocognitive sequelae of repeated concussive injuries[20] (cases 1 and 10).

Most competitive athletes are highly invested in their sport, and many feel personally defined by their participation.[40] Suggesting a replacement activity such as a noncontact sport (case 8) may make giving up contact sports more tolerable. For personal reasons, some patients may decide on a hiatus

from sport (temporary or permanent) despite rapid and normal recovery (case 6). Voluntary retirement from sport is consistently associated with more favorable psychosocial outcomes in former athletes and providers should make strong recommendations rather than mandates whenever possible.[10] Distress associated with the transition out of an athletic career occurs in 15%–20% of all athletes, is more common following involuntary retirement, and should be a focus of continued follow-up care provided after retirement.[10] In the case that an athlete considers a return to sport after a long hiatus, the algorithm remains applicable, though patient-centered factors, such as discussing the value of contact sport in his or her life, may play an even larger role.

This empirically derived algorithm is not without limitations. Our recommendations are drawn from the collective experience of a small number of providers who have nonetheless longitudinally managed SRC in athletes of all levels using a consistent data-driven approach over time. In recent years, athletes and families have generally become more aware, informed, and concerned about concussion through the lay press and personal research, and our group has increasingly been asked by patients to help consider discussions informed by the algorithm. Certainly, more evidence is needed validate our approach and determine which factors used in our algorithm are most clinically relevant.

Author contributions

C. Davis-Hayes: drafting/revising the manuscript, study concept or design, analysis or interpretation of data, acquisition of data. D.R. Baker: drafting/revising the manuscript, study concept or design, analysis or interpretation of data. T.S. Bottiglieri: drafting/revising the manuscript, study concept or design. W.N. Levine: drafting/revising the manuscript, contribution of vital reagents/tools/patients, acquisition of data, study supervision. N. Desai: drafting/revising the manuscript, analysis or interpretation of data. J.D. Gossett: drafting/revising the manuscript, study concept or design, analysis or interpretation of data, acquisition of data, study supervision. J. Noble: drafting/revising the manuscript, study concept or design, analysis or interpretation of data, acquisition of data, study supervision.

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TAKE-HOME POINTS

- Medical disqualification may be necessary in select athletes with complex history of concussion in sport
- Real-world cases of sports-related concussion informed this novel treatment algorithm to guide clinicians through consideration of medical retirement following concussion
- Some decision points are based on limited research and require further validation.

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