Review Article



# Clinical considerations for the assessment, management, and treatment of concussion in females

**Katie Stephenson[1], Melissa N. Womble[2], Nadia Hawa[2], Robert J. Elbin[1]**

[1]Office for Sport Concussion Research, University of Arkansas, Fayetteville, AR, USA; [2]Inova Sports Medicine Concussion Program, Fairfax, VA, USA

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*Correspondence to:* Melissa N. Womble, PhD. 8100 Innovation Park Drive, Suite 110 Fairfax, VA 22031, USA. Email: Melissa.Womble@inova.org.

**Abstract:** This review paper describes an individualized, targeted clinical care approach for the assessment, management, and treatment of sport-related concussions (SRC), and also highlights important clinical considerations for providing care to females with a SRC. Ideally, SRCs should be managed by an interdisciplinary medical team including but not limited to neuropsychologists, primary care sports medicine physicians, and physical therapists. The clinician that coordinates care should employ a multi-modal assessment approach (e.g., neurocognitive, vestibular/ocular motor, symptoms, balance, clinical exam/interview) to capture the heterogeneity of symptoms and impairments that are associated with SRC. Clinicians must also be aware of certain factors, specific to females that may complicate SRC recovery such as female preferences for clinical care, their greater risk for established risk factors (e.g., concussion history and migraine) and female sex hormone cycles that may influence multiple concussion outcomes (e.g., symptom reports and neurocognitive scores). Concussion management has moved away from a one-size-fits-all approach and clinicians must be willing to provide a comprehensive assessment that caters to the needs of females in order to individualize the treatment recommendations and avoid a prolonged recovery.

**Keywords:** Concussion; female athletes; clinical considerations

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Approximately 1.6 to 3.8 million sport- and recreation-related concussions (SRC) occur every year (1). A SRC is a complex pathophysiological process resulting from biomechanical forces that are transmitted to the head in a direct or indirect manner (e.g., whiplash) (2). This injury results in a constellation of signs, symptoms, and impairments that can negatively affect cognitive, physical, emotional, and sleep-related functioning. The current recommended clinical care model for SRC includes a thorough clinical interview combined with a multi-modal assessment approach that are amalgamated and used to identify a predominant clinical profile (3) that has a corresponding, targeted management and treatment plan (e.g., vestibular or vision therapy). This patient-centered care approach accounts for the influence of both personal and injury-related risk factors (e.g., migraine history) that may influence diagnostic and prognostic outcomes.

The research examining gender differences on the incidence of SRC and recovery outcomes is equivocal. Some researchers report that in sports played by both males and females, females sustain more concussions (4), endorse more symptoms (5) and exhibit longer concussion recovery (6) compared to males. However, these findings have not been consistently replicated in the literature. Regardless of the inconclusive nature of this literature, there are several clinical considerations that sports medicine professionals should keep in mind when assessing, managing, and treating females with SRC. This review paper will describe an individualized, targeted clinical care approach for the assessment, management and treatment of SRC as well as

**Table 1** Risk factors for poor clinical outcome and protracted recovery following SRC

| (Primary) pre-injury risk factors | (Secondary) post-injury risk factors |
|---|---|
| Younger age | Loss of consciousness |
| Female gender | On-field dizziness |
| Concussion history | Continuing to play with SRC |
| Attention deficit hyperactivity disorder | High symptom burden |
| Learning disorder | Retrograde and post-traumatic amnesia |
| Motion sickness | Post-traumatic migraine |

SRC, sport-related concussion.

important clinical considerations for the concussed female athlete within this clinical care model.

## The clinical interview for SRC

The clinical interview is a dialogue between the clinician, patient, and included family members which forms the foundation for the clinical visit. The goal of the clinical interview is to gain a better understanding of the patient's medical history and details of the SRC in order to identify factors that may influence recovery and make recommendations for targeted management and treatment options. The clinical interview also serves as an opportunity for the clinician to establish rapport and strengthen the therapeutic alliance with the patient (7). The therapeutic alliance is multidimensional and incorporates communication, integration, collaboration, and patient empowerment in the patient-provider relationship (8) and is linked to symptom reporting (9) and greater patient satisfaction (10). A strong therapeutic alliance may enable the concussed patient to be more forthright and comfortable about disclosing their symptoms and impairments following injury.

There are several general recommendations that outline the steps that healthcare providers can use to strengthen the therapeutic alliance (11,12), and there are also more pertinent empirical findings that highlight gender differences among this concept as well as expectations from healthcare providers during recovery (13). The therapeutic alliance is associated with increased warmth/friendliness, affirming/understanding, decreased belittling/blaming and attacking/rejecting provider-patient interactions (12). Further, female patients tend to prioritize specific qualities, such as trust, closeness, empathy, and positive regard in the process of building the therapeutic alliance (11). Clement and colleagues (13) reported that female patients expect clinicians to provide an environment that is accepting, nurturing, and trusting to facilitate personal growth and rehabilitation. A strong therapeutic alliance is needed to further elucidate an accurate health history.

The personal health history and injury-related information that is obtained in the clinical interview should be used to identify risk factors that may influence performance on SRC assessments and further inform management and treatment strategies. In addition, these risk factors may not only affect the clinical presentation of the patient (e.g., lower neurocognitive performance in individuals with learning disability), but can also negatively influence SRC recovery time. Established risk factors for SRC outcomes are reviewed in several papers (14,15) with the more common risk factors reported in the literature listed in *Table 1*. Although gender is a recognized risk factor for SRC outcomes, this variable may also interact with other factors and complicate the management of SRC.

Some risk factors, such as migraine history, mood disorders (e.g., depression, anxiety) and phase of menstrual cycle, are more prevalent in females compared to males and may require additional clinical consideration and/or care when managing SRC. There is a greater preponderance of migraine history in females compared to males, and history of migraine (both personal and familial) is associated with poor outcomes following SRC (16). Similarly, pre-morbid and co-morbid depression and anxiety are linked to poor SRC recovery outcomes (14) and females are more likely to be diagnosed with depression (17) and anxiety during their lifetime compared to their male counterparts (18).

Clinicians should also inquire about phase of menstrual cycle and hormonal contraceptive use during the clinical interview as this information may explain elevated symptom reporting and menstrual irregularities during recovery from SRC (19,20). The post-concussion and menstrual symptoms that overlap include anxiety, lability, irritability, difficulty concentrating, lethargy, sleeping difficulties, and headaches (21,22). Wunderle and colleagues (20) reported that women whose concussions occurred during the luteal phase endorsed higher somatic symptoms compared to women that sustained their concussion in the follicular phase. Wunderle and colleagues (20) also reported fewer concussion symptoms in women taking hormonal contraceptives, which is also reported in other studies (23).

In contrast to the literature investigating the effect of menstrual cycle on concussion outcomes, there appears to be an effect of concussion on menstrual cycle regulation. Snook and colleagues (19) reported that females with a SRC were 5.85 times more likely to experience two or more abnormal menstrual bleeding patterns during recovery compared to orthopedic-injured controls. The relationship between fluctuations of sex hormones during the menstrual cycle and their effects on concussion outcomes is complex, as there is a large overlap of concussion and menstrual cycle symptoms, and the mechanism of these aforementioned associations between menstrual cycle and concussion outcomes (e.g., neurocognitive function and symptom reports) are unclear. However, both of these variables may explain unanticipated changes in symptoms or menstrual cycle in females with SRC.

## A multi-domain assessment approach for SRC

Current consensus statements encourage the use of multiple clinical assessments to better capture the various symptom presentations and impairments associated with SRC (2). These clinical measures broadly include symptom, neurocognitive, vestibular, ocular, and postural stability assessments. Recent emphasis and research on the pre-morbid and co-morbid effects of mental health on SRC outcomes (24) has also uncovered the need for clinicians to consider incorporating self-report mood assessments (e.g., anxiety and depression) during the SRC evaluation. Although subjective symptom reporting remains the centerpiece of the SRC evaluation, other measures (e.g., computerized neurocognitive testing, vestibular, ocular motor) can increase the objectivity for the clinical evaluation of SRC. In fact, The National Institute for Neurological Disorders and Stroke (NINDS) has identified a set of Common Data Elements (CDEs) that inform which domains to assess when providing care for SRC (25). Similar to the clinical interview, assessment of concussion also calls for the careful consideration of gender when administering and interpreting data from these tools.

## Symptom assessment

There are a number of concussion symptom inventories available for use and although subjective, these assessments are a major part of the evaluation process for SRC. Symptom inventories help characterize the acute, sub-acute and chronic effects of concussion, determine a clinical profile, and serve as a marker of recovery. The internal consistency of popular symptom scales (e.g., Head Injury Scale, Post-Concussion Symptom Scale, and Graded Symptom Checklist) is high (Chronbach's alpha = 0.78 to 0.94) (26) and the sensitivity and specificity ranges from 0.41 to 0.89 and 0.79 to 1.0 for these measures (26,27). The most frequently reported post-concussion symptoms are headaches, difficulty concentrating, fatigue, and drowsiness (21), which are conceptualized into clinical factors (e.g., cognitive-migraine-fatigue, affective, somatic/physical, and sleep) for increased ease of understanding and interpretation (21).

There are gender differences in post-concussion symptom reporting. Females report a greater number (28) and a higher severity (5) of post-concussive symptoms compared to males. These reporting differences are attributed to females being more forthright in their symptom reports (29). In addition, females are more likely to endorse more physical (e.g., headache, dizziness, nausea, and vomiting) and somatic symptoms (e.g., poor sleep, and sensitivity to light and noise) compared to their male counterparts (30). These differences in symptom reporting between genders might be due to the overlapping symptoms from other aforementioned factors such as phase of menstrual cycle or migraine history (20).

Somatization, pain catastrophizing, and co-morbid mood disorders influence symptom reporting following SRC and may be modified by gender. Somatization, or the endorsement of symptoms that cannot be explained by a known physical disease, is reported to occur in 55% of patients with concussion and is associated with protracted recovery in females with SRC (31). Similarly, pain catastrophizing, or symptom amplification due to the misinterpretation of symptoms as threatening, has been reported to be associated with adverse concussion outcomes (i.e., post-concussion syndrome) (32). In addition, overlapping symptoms of other mood disorders (e.g., depression or anxiety) may complicate the assessment and management of SRC. For example, 90% of patients with depression met criteria for post-concussion syndrome (33), which is important to disentangle following SRC. The somatization, pain catastrophizing, and co-morbid mood disorders can complicate symptom reports from individuals with SRC and should be screened by clinicians.

## Vestibular and ocular motor assessment

Approximately 60–70% of adolescents report vestibular and/or ocular-motor impairment following SRC (34),

and until the recent development of the Vestibular/Ocular Motor Screening (VOMS); the vestibular and ocular motor assessment for SRC was time consuming and required specialty training to conduct. The VOMS is a brief screening tool that evaluates symptom provocation on a series of ocular (pursuits and saccades) and vestibular (vestibular ocular reflex and visual motion sensitivity) tests in addition to measurement of near point of convergence distance (34). The VOMS is not related to other balance measures commonly used for SRC (Balance Error Scoring System; BESS) and represents a unique assessment of the vestibular-ocular system (35). The VOMS has a high sensitivity for detecting SRC (34), and the items are internally consistent (Chronbach's alpha = 0.92–0.95) (34,35). Gender differences in post-concussion vestibular and ocular motor functioning is relatively understudied, however the results from other non-SRC related vestibular conditions reveal that females exhibit increased symptoms compared to males. In one of the only studies to date on this topic, Sufrinko and colleagues (5) reported females exhibited higher symptom provocation on the vestibular ocular motor reflex component compared to males. Other researchers reported similar vestibular and ocular motor functioning in non-concussed male and female youth athletes (36). Overall, there are a lack of studies examining gender differences on vestibular and ocular motor function in individuals with SRC and additional research examining gender differences is warranted.

## Postural stability assessment

Approximately 66% of concussed athletes experience balance impairments following SRC (37). The BESS is one type of balance assessment that can be used in the field setting and may be useful in detecting postural instability in the acute phase following SRC. However, recent consensus statements caution the use of balance assessments past five days following SRC due to decreased utility. Moreover, there are several guidelines for administering balance assessments that clinicians should be aware of that include footwear, surface, and reliability of test administrators. In terms of gender differences and or specific clinical considerations for assessing balance in female athletes with SRC—the literature is inconsistent (38,39). There are no differences in postural stability performance at the beginning and end phases of the menstrual cycle in non-concussed females, regardless of oral contraceptive use (40), suggesting that postural stability is not affected by menstrual cycle.

## Neurocognitive assessment

Neurocognitive testing is a commonly used SRC assessment and adds objectivity to the clinical assessment toolbox. Among certified athletic trainers, who are often responsible for the detection and management of SRC in high school and collegiate athletes, approximately 40-75% utilize neurocognitive testing (41,42). Both paper-and-pencil and computerized testing platforms are used for concussion assessment (see NINDS CDE) (25) and these assessments can be useful tools if administered and interpreted correctly. A benefit of computerized platforms is the ability to easily obtain baseline neurocognitive data on athletes (via group or individual testing sessions) prior to the competition season. These baseline scores serve as an estimate of neurocognitive performance and can be used as a reference for a concussed athlete. Allowing an athlete to serve as their own control accounts for the potential effects of confounding factors that are specific to that athlete and can complicate SRC management. In cases where baseline scores are not obtained, some neurocognitive tests have published age and gender normative data.

Several researchers have examined gender differences on neurocognitive performance at baseline and following concussion. Overall, the well-established neurocognitive differences between males and females are still prevalent on baseline neurocognitive testing used for management of SRC (i.e., females exhibit better performance on verbal-based tasks and males exhibit better performance on visuospatial-based tasks) (43). In contrast, studies comparing post-concussion neurocognitive outcomes between males and females are equivocal (5,44). Although the between-gender examination of post-concussion neurocognitive outcomes provide additional empirical knowledge, these findings may have limited clinical application due to the within-subject design of the SRC visit. More specifically, the sports medicine professional that is providing care to a female patient with a concussion is likely less concerned about how her patient's scores compare to males, but more concerned with what factors the female has that may be accounting for the neurocognitive improvement or deterioration observed by the healthcare provider. Therefore, it is more clinically relevant to examine other factors that may influence neurocognitive performance within females such as the aforementioned effects of the menstrual cycle and specific clinical findings (e.g.,

vestibular sensitivities, ocular-motor abnormalities). For example, several studies have investigated the influence that menstrual cycle phase had on baseline neurocognitive testing and reported no significant differences in neurocognitive performance between the early and late phase of the menstrual cycle in non-concussed females (40). Although several studies have examined gender differences on pre- and post-concussion neurocognitive performance, the within-subjects effect of factors inherent to female athletes, such as the menstrual cycle, do not complicate the neurocognitive assessment of the female athlete.

## Management and treatment

Amalgamating the information obtained from a thorough clinical interview and multi-modal assessments enables the clinician to identify a clinical profile(s) that can be matched to a corresponding management and treatment/rehabilitation plan (3). A recent clinical consensus recognized that SRC could be best characterized into five clinical profiles (e.g., Vestibular, Ocular, Cognitive/fatigue, Migraine, and Anxiety/mood) and two modifiers (e.g., sleep impairments and cervical pain) (3). The composition of each profile and modifier with recommended treatments are presented in several clinical review articles (15). The clinical profiles are primarily derived from a combination of medical history, risk factors, injury information, clinical characteristics, and assessment outcomes (15). However, several studies supporting various components of this model have been recently published (3). Most recently, Kontos and colleagues (3) examined co-occurring profiles and found that certain primary profiles were associated with specific secondary profiles. For example, athletes with ocular as a primary profile were more likely to have cognitive/fatigue as a secondary profile compared to other primary profiles (15). In addition, the primary profiles with the highest frequency are migraine, anxiety/mood, and vestibular (3). There are several proposed management and treatment strategies for SRC that range from behavioral regulation, vestibular therapy, visual rehabilitation, academic/work accommodations, exertion therapy, psychotherapy, and pharmacological interventions. To date there is a paucity of research providing strong empirical support for these treatment options, and most of the evidence behind these interventions is borrowed from other areas of medicine. These approaches are noted to be anecdotally supported for concussion treatment and research validating the efficacy of these measures is currently ongoing (15,45).

## Recovery time

The recovery time for SRC has been a hot topic in the concussion literature for the past 15 years. Earlier studies reported that SRC recovery ranged from 5 to 7 days (46) and more recent reports indicate that SRC recovery occurs two to three weeks after injury (47). There are numerous reasons for the disparate recovery time periods that may include varying operational definitions of recovery, differences in evaluation standards over time, differences in concussion evaluation components amongst providers, and advances in treatment recommendations. For example, some studies classify recovery as being asymptomatic, whereas others classify recovery as returning to baseline or to norms on multiple assessments (e.g., symptoms, neurocognitive functioning and vestibular/ocular-motor function). Although these recovery times encompass the majority of presentations, there is a miserable minority of ~20% of individuals with SRC that will not recover in the two to three week time frame (48). As previously stated, clinicians can estimate the likelihood of concussed individuals experiencing this protracted recovery by identifying primary and secondary SRC risk factors (14). Moreover recent evidence suggests that the early initiation of sub-symptom threshold physical activity is beneficial for recovery (2). Given the deleterious consequences of prescribed rest past the first 24–48 hours, patients are also being encouraged to reintegrate into their academic and social activities in an effort to mitigate post-SRC mood disorders and/or complications such as anxiety (49). More specifically, females are reported to have a higher tendency to internalize anxiety and emotion, which may negatively influence their effort toward reintegration following SRC. This highlights the need for clinicians to strengthen the therapeutic alliance and rapport with females in order to expedite their recovery from SRC.

## Conclusions

Concussion is a heterogeneous injury that warrants a multimodal assessment with an accompanying individualized management and active treatment approach (see more information on individualized management and treatment in Appendix 1). Despite the recent evolution of concussion care that has moved from a one-size-fits-all approach to a patient-centered model, certain considerations are required when providing care for females. Overall the literature and experiences from clinical care suggest that females may

differ from males on several concussion outcomes and given the higher prevalence of some pre-morbid factors (i.e., migraine), females may present differently at different times throughout the recovery process and be at a higher risk for prolonged recovery outcomes.

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*Ethical Statement:* The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.



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## Supplemental questions

***1. Dr. Robin V. West: Are there home recovery programs that can be given to post-concussion patients?***

**Author's Answer:**
Yes, there are home recovery programs that can be provided to patients recovering from concussion. Most often, home recovery programs are developed for those individuals recommended to receive vestibular, cervical and/or vision therapies following concussion. It is important to note that not everyone recovering from concussion requires specific therapies following their injury and these are recommended individually based on the identified clinical profile(s) and clinical presentation. Some individuals only require home management which typically involves implementation of a regulated daily schedule (i.e., eating regular meals, staying well hydrated, engaging in daily physical activity, maintaining a regular sleep schedule and managing stress) as well as use of short breaks throughout the day to help with management of symptoms.

***2. Dr. Robin V. West: When a patient with pre-disposing risk factors to a prolonged recovery or poor outcome presents to you following a concussion, what do you do differently during that first appointment when compared to a patient who has no pre-injury risk factors?***

**Author's Answer:**
In general, you do not have to do anything differently as long as your first appointment with every patient is comprehensive (i.e., includes multiple assessment tools, includes detailed clinical interview with relevant pre-injury risk factors, review of current symptoms) and includes all the necessary components to fully evaluate the injury. That being said, the biggest differences or consideration points for those with pre-injury risk factors tends to be rate at which a therapy and/or medication may be recommended. For example, in an individual with a history of migraines that is showing a migraine profile post-concussion medications may be initiated sooner. Additionally, providing education at that initial appointment for those with pre-injury risk factors is important in terms of setting appropriate expectations which can ultimately reduce stress and improve overall recovery.

***3. Dr. Robin V. West: Is it safe to "clear" an athlete to return to play if they are symptom-free but have continued "abnormal" findings on VOMS?***

**Author's Answer:**
The short answer is "yes" it can be safe in certain circumstances though it is rather rare to have abnormal findings upon clearance. The VOMS, like any other tool used post-concussion, is meant to be used in conjunction with other measures to fully evaluate all aspects that can be affected post-concussion and therefore it is not meant to be an end-all-be-all in terms of determining clearance. Some individuals with certain pre-existing histories (e.g., lazy eye, motion sickness, migraine) may be more likely to obtain "abnormal" findings and therefore these factors must be considered when evaluating results. Additionally, results can sometimes be affected by external factors such as mood (e.g., anxiety) and/or another illness (e.g., allergies, flu).


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