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Original research

The diagnostic utility of clinical tests for differentiating between cervicogenic and other causes of dizziness after a sports-related concussion: An international Delphi study

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ABSTRACT

Objectives: Dizziness after a sports-related concussion is very common and is associated with prolonged recovery. The events in sports that cause concussion include strong mechanical forces exerted to the head and neck, potentially injuring the cervical region, the peripheral vestibular and central nervous system, all of which can contribute to a sensation of dizziness. The purpose of this study was to identify proper clinically administered tests and measures that are useful in differentiating between cervicogenic and other causes of dizziness after a sports-related concussion.
Design: The Delphi method.
Methods: The workgroup identified the initial list of suggested clinical tests and the initial list of content experts on dizziness and/or concussion through a search of peer-reviewed and grey literature. The respondent group included all invited experts who opted to participate. A sequential three-round process was used for elicitation of consensus opinions from the targeted content experts.
Results: The respondent group included 25 members from several medical disciplines who were experts in concussion and dizziness. At the conclusion of the study, ten clinical tests achieved the designation of strong clinical utility, six were determined to have weak clinical utility and seven achieved no consensus among the experts.
Conclusions: The majority of clinical tests identified as having strong clinical utility are tests used to identify dizziness originating from the vestibular or central nervous system. No clinical tests specific for the cervical region achieved consensus. Expert opinion from different medical professions and even within professions was widely divergent regarding the utility of clinical tests to assess cervical dysfunction.
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1. Introduction

A concussion is a brain injury, induced through traumatic biomechanical forces, which, in a majority of cases typically resolves in 7–10 days.[1,2] The most common causal event associated with a concussion is being struck or kicked during sports.[3] Dizziness is the second most regularly reported compliant associated with concussion,[2,4] behind headache, and is stated to occur in 23–81% of diagnosed cases.[5] If present at the time of the concussion, the odds of a prolonged recovery are 6.34 when compared to athletes with concussion who do not have dizziness on-field.[6] Although concussion is largely transient, 10–20% of cases do not follow the typical timeline for recovery, and experience prolonged symptoms.[1]

Dizziness is also a complaint in patients with whiplash injury, affecting 20–58% of individuals with flexion-extension injuries.[7] A debated origin of dizziness is cervicogenic dizziness (CD),[8] which is thought to be caused by dysfunction in the upper cervical spine.[9] When neck pain and dizziness appear simultaneously, it is difficult to ascertain if there is a causal relationship between the two symptoms, specifically since the most common causes of dizziness are from vestibulocochlear and central nervous system disorders.[10] A complaint of neck pain after a sports-related concussion is not surprising since the concussive event may be caused by a direct blow to the head, face, neck, or elsewhere on the body with an

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"impulsive" force transmitted to the head.[1] In the presence of concussion and dizziness, the challenge of an appropriate diagnosis becomes complicated.

There is potential for flexion-extension, rotational, or compression types of cervical injury concurrent to the event causing a concussion.[11,12] With the knowledge that the cervical spine can contribute to the sensation of dizziness,[7,8] and with dizziness being so strongly associated with prolonged recovery,[6] it is of great importance for clinicians to have an assessment that can determine the presence of cervical dysfunction and its contribution to the vague complaint of dizziness so that specifically targeted treatments can be delivered to alleviate this distressing sensation. At present, there are no studies that have explored the most appropriate diagnostic techniques for dizziness of neck origin in subjects diagnosed with concussion. In the absence of evidence to drive decision making, expert opinion is the most frequently warranted decision making driver and a Delphi survey is designed to distill and obtain the most reliable consensus from a group of experts.[13] Consequently, the purpose of this study was to use a Delphi approach to identify clinically administered tests and measures that are useful in the differentiating between cervicogenic and other causes of dizziness after a sports-related concussion.

2. Methods

This study used the Delphi method for elicitation of consensus opinions from the targeted content experts.[14] The Delphi incorporated both a workgroup and a participant (respondent) group of content experts to answer the question: *What clinical tests and measures could be included in an assessment to differentiate between cervicogenic and other causes of dizziness in concussed athletes*? The research protocol was approved by the lead author's university Ethics Committee. Informed consent was obtained from each respondent prior to participation.

Experts on the topics of concussion and dizziness were systematically identified to be members of the respondent group through two strategies, with the goal of establishing an initial list of 100 potential participants. First, computerized searches of PubMed using combinations of MESH terms associated with dizziness, concussion, and diagnosis of cervicogenic-oriented conditions were completed. Relevant manuscripts were identified through a review of the title of the article and the abstract by study personnel. All first and last authors of relevant studies were selected for the study population, beginning with the most recent publications. Second, experts were identified by searching through Google for grey literature, which included recent national and international conference proceedings, textbooks, and other non-peer-reviewed nationally or internationally published material. These groups were targeted because of their recognized clinical and/or research expertise in the area of assessment and treatment of dizziness and concussion.

The workgroup consisted of three individuals who identified the initial list of clinical tests potentially useful in the differential diagnosis of dizziness after concussion and who were the authors of this manuscript. The primary investigator (JR) was a board certified neurologic clinical specialist with doctoral training in epidemiology; one investigator (CM) had advanced vestibular certification and training in spinal manipulative therapy and the final investigator (CC) was a fellow in the *American Academy of Orthopaedic and Manual Physical Therapists* with research expertise in both qualitative, quantitative, and mixed methods including the Delphi method.

This Delphi consisted of an initial preparatory phase by the workgroup and three rounds of electronic questionnaires that the respondents completed consecutively.

During the preparatory phase, prior to the initiation of Round I, the workgroup selected 21 tests that were specific and non-specifically associated with vestibular-, cervical-, postural-, and concussion-associated examination. These preliminary tests were selected through a search of the literature, textbooks, and from the investigators clinical practice expertise.

An individual introductory e-mail was sent to the list of identified experts from the primary investigator's e-mail to inform them of their identification as an expert and to alert them that they would receive an e-mail link for Round I in two weeks. Two weeks later, the invitation for participation with the link to the informed consent and the Round I survey was sent electronically to all experts who did not decline participation after the introductory e-mail. This initial link was active for 21 days. Three follow up e-mails were sent to all non-responders every 5 days after the initial e-mail was sent. Throughout the three-round process, all participants remained blinded to the identity of the other participants in the Delphi respondent group.

For Round I, respondents were asked to provide qualitative comments about the usefulness of each the 21 preliminary tests. They were instructed that these comments could include appropriate administration of tests according to time or severity parameters after concussion, modification of the test description, expansion of the indication of a positive finding, or suggestions for additional appropriate tests and measures. The Round I survey also included basic demographic questions, an overview of the Delphi method, the roles and definition of the workgroup and respondent groups, and asked participants to indicate if they would permit acknowledgement as members of the respondent group in resultant deliverables.

After the information was recorded by the electronic survey tool, the workgroup summarized the qualitative comments returned from Round I and redesigned the list of clinical tests included in Round II and, eventually Round III. To do this, the individual members of the workgroup independently reviewed all of the comments provided by the Delphi participants prior to convening for discussion. The requirements for modification were twofold: 1) identification of three or more comments from the participants that indicated a common theme, 2) consensus among the workgroup that there was a trend in the responses that needed to be addressed. If these 2 criteria were met, then a modification was made. Through this process, the workgroup exhausted all commonalities in the respondents' suggestions in order to re-populate a new set of tests and measures.

Invitations for Round II and Round III were automatically distributed via e-mail to all participants from Round I. Round II and Round III were open for response for 14 days and e-mail reminders were sent every three days to non-respondents. Round II included the revised list of clinical tests (based on the responses from Round I). For Round II, the following patient situation was provided to contextualize the respondents' thought process. *Patient: An athlete with a concussion who has a complaint of dizziness. Scenario: All appropriate imaging and tests have been done to rule out high risk injuries, including but not limited to, the presence of a skull fracture, cervical fracture, or cervical ligamentous instability. These have been completed to ensure safety as you proceed with a clinical assessment. You have already completed a robust patient history and subjective interview to guide the physical examination.*

In Round II, the respondents were asked to score the diagnostic clinical utility of each test defined as "the extent that diagnostic testing influences post-test decisions and improves health outcomes relative to the current best alternative, which could be some other form of testing, or not testing at all."[15] A four point Likert scale: "very strong clinical utility", "strong utility", weak utility", or "very weak utility" was used to quantify scores. An optional