Peroneal Reaction Time and Ankle Sprain Risk in Healthy Adults: A Critically Appraised Topic

Matthew C. Hoch and Patrick O. McKeon

Clinical Scenario

Ankle sprains are one of the most common injuries identified in athletics, the military, and hospital emergency rooms. A significant number of patients report injury recurrence, residual symptoms, ankle instability, and functional loss associated with a single acute sprain. Identifying modifiable risk factors for sustaining ankle sprains is essential to develop effective injury-prevention strategies. A contributing factor of recurrent ankle instability has been proposed to be delayed peroneal reaction time in response to ankle perturbations. There is also the possibility that this is a risk factor associated with sustaining initial ankle sprains.

Focused Clinical Question

Is delayed peroneal reaction time in response to perturbation a risk factor for sustaining lateral ankle sprains in healthy adults?

Summary of Search, Best Evidence Appraised, and Key Findings

- The literature was searched for studies of level 2 evidence or higher that investigated whether peroneal reaction time in response to perturbation was a risk factor for sustaining lateral ankle sprains in physically active healthy adults.
- The search of the literature returned 5 possible studies for inclusion; 3 cohort studies met the inclusion criteria and were included.
- None of the studies identified peroneal reaction time in response to perturbation as a risk factor for sustaining ankle sprains.

Clinical Bottom Line

There is moderate evidence suggesting that peroneal reaction time in response to perturbation is not a risk factor for sustaining ankle sprains in healthy adults.

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**Strength of Recommendation:** There is level B evidence that peroneal reaction time in response to perturbation is not a risk factor for sustaining ankle sprains in healthy adults.

**Search Strategy**

**Terms Used to Guide Search Strategy**
- **Patient/Client group:** adult
- **Intervention (or assessment):** peroneal reaction time and inversion or perturbation
- **Comparison:** no intervention and control
- **Outcome(s):** ankle sprain and risk

**Sources of Evidence Searched**
- MEDLINE
- CINAHL
- SPORTDiscus
- Cochrane Library
- PEDro
  - Additional resources obtained through review of reference lists and hand search

**Inclusion and Exclusion Criteria**

**Inclusion**
- Prospective studies investigating risk factors for sustaining ankle sprains
- Prospective studies investigating lower extremity injury if subanalyses for ankle sprain were reported
- Peroneal reaction time after sudden ankle perturbation investigated as a risk factor for sustaining injury
- Level 2 evidence or higher
- Limited to English language
- Limited to humans
- Limited to the last 10 years (2001–2010)

**Exclusion**
- Retrospective studies examining contributing factors for ankle sprain
- Prospective studies examining lower extremity injuries that did not specifically report ankle sprains
- Studies that did not include peroneal reaction time as a potential risk factor for sustaining ankle sprain
- Studies including subjects with a history of ankle sprains
Results of Search

Three relevant studies were identified and categorized as shown in Table 1 (based on levels of evidence, Centre for Evidence Based Medicine, 1998).1–3

Best Evidence

These 3 studies were identified as the best evidence and selected for inclusion in the CAT (Table 2). Reasons for selecting these studies were because they were graded with a level of evidence of 2 or higher and examined peroneal reaction time in response to perturbation as a risk factor for sustaining ankle sprains in otherwise healthy adults.

Implications for Practice, Education, and Future Research

All 3 studies appraised here indicated that peroneal-reaction-time deficits are not present in healthy individuals who sustained an ankle sprain during prospective observation. We concluded that a level B recommendation could be made that peroneal reaction time is not a risk factor for sustaining ankle sprains because the included studies were categorized as level 2 evidence and consistently displayed no differences between individuals who sustained an ankle sprain and those who did not sustain any lower extremity injuries. All 3 studies in this review appeared to be high-quality cohort studies, based on identifying most applicable items described in the Strengthening the Reporting of Observational Studies in Epidemiology Statement (STROBE Statement, STROBE Initiative, 2007) for designing quality cohort studies. All 3 studies had similar deficiencies including not describing potential sources of bias, not explaining how study size was determined, and not providing specific timelines or reasons associated with dropout. The findings of this appraisal indicate that although peroneal-reaction-time deficits have been hypothesized to contribute to lateral ankle sprains, there is a lack of evidence suggesting that deficits in this dynamic defense mechanism are present before injury and therefore responsible for the high number of ankle sprains experienced by physically active individuals.

The conclusion reached in this CAT is that peroneal reaction time after ankle perturbation may not be of clinical importance for preventing lateral ankle sprains. This does not indicate that perturbation training is ineffective for preventing

Table 1  Summary of Study Designs of Articles Retrieved

<table>
<thead>
<tr>
<th>Level of evidence</th>
<th>Study design</th>
<th>Number located</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Cohort studies</td>
<td>3</td>
<td>Willems et al¹</td>
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<td>Willems et al²</td>
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<td>Beynnon et al³</td>
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## Table 2  Characteristics of Included Studies

<table>
<thead>
<tr>
<th>Study design</th>
<th>Willems et al(^1)</th>
<th>Willems et al(^2)</th>
<th>Beynnon et al(^3)</th>
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<tbody>
<tr>
<td>Participants</td>
<td>241 male college physical education students (18.3 ± 1.1 y) who were freshman in 2000–01, 2001–02, or 2002–03. Exclusion criteria were history of a foot or ankle surgical procedure, previous grade II or III ankle sprain, or history of lower extremity injury in the previous 6 mo. All participants followed the same sports program. Activity in the program and extramural athletic activity were documented for each participant. Participants reported all injuries to the same physician, who evaluated and documented all injuries.</td>
<td>159 female college physical education students (18.3 ± 1.1 y) who were freshman in 2000–01 (n = 53), 2001–02 (n = 50), or 2002–03 (n = 56). Exclusion criteria were history of a foot or ankle surgical procedure, previous grade II or III ankle sprain, or history of lower extremity injury in the previous 6 mo. All participants followed the same sports program. Activity in the sports program and extramural athletic activity were documented for each participant (15.33 ± 4.33 h/wk). Participants reported all injuries to the same physician, who evaluated and documented all injuries.</td>
<td>118 Division I college varsity athletes (50 men, 68 women) age 18–23 y who competed in lacrosse, soccer, or field hockey during the 1994–95 season. Exclusion criteria were previous history of ankle sprain, foot or ankle surgery, sustained trauma to the lower extremity, or using external ankle support. The men had 4,249 d and women had 5,813 d of sport exposure. All ankle injuries were evaluated by an orthopedic surgeon at the time of injury.</td>
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## Table 2 (continued)

<table>
<thead>
<tr>
<th>Study design</th>
<th>Willems et al&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Willems et al&lt;sup&gt;2&lt;/sup&gt;</th>
<th>Beynnon et al&lt;sup&gt;3&lt;/sup&gt;</th>
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<tr>
<td>Intervention investigated</td>
<td>All participants were evaluated for risk factors possibly associated with incidence of ankle sprain, including anthropometrical characteristics, ankle-joint position sense, muscle strength, lower leg alignment, postural control, and muscle reaction time. Peroneal reaction time was assessed through surface electromyography (EMG) of the peroneus longus and brevis muscles and a custom inversion perturbation platform that enabled each foot to unexpectedly drop into plantar flexion/inversion of 50° from standing in 40° of plantar flexion and 15° of adduction. The onset of activity was determined by the first muscle activity after tilting, which was 2 SDs above baseline muscle activity lasting 3 ms. The time from the start of the follow-up period until ankle sprain or the end of the follow-up period was recorded for each subject.</td>
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<td>Before preseason training, all participants were evaluated for potential ankle-sprain risk factors including demographic information, generalized and ankle-joint laxity, alignment of the foot and ankle, isokinetic ankle strength, postural control, and muscle reaction time. Peroneal reaction time was assessed using surface EMG of the peroneus longus and brevis in conjunction with a platform creating 4° inversion rotation perturbation of the foot at 50°/s. Each participant underwent the inversion perturbations until 10 EMG tracings were recorded. Medium-loop of the peroneal muscles was evaluated as the time lag between joint perturbation and muscle activation. All subjects were monitored throughout the season, documenting athletic exposure and injury sustained during participation.</td>
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<td>Outcome measure</td>
<td>Participants were divided into a group that sustained no lower extremity injuries (n = 108) and a group that sustained an inversion ankle sprain (n = 44). A Cox proportional hazard regression tested the effect of peroneal reaction time on risk of injury.</td>
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<td>Men and women were separated by those who sustained an ankle sprain and those with no injuries (men: 7 ankle sprain, 43 no injury; women: 13 ankle sprains, 50 no injury). A Cox proportional hazard regression tested the effect of peroneal reaction time on risk of injury.</td>
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<td>Results</td>
<td>44 (18%) of the 241 participants sustained an inversion ankle sprain. No significant differences were observed between the uninjured group and the ankle-sprain group for peroneal reaction time (P &gt; .05). Peroneus longus uninjured: 83.12 ± 14.12; injured: 75.99 ± 10.06 ms. Peroneus brevis uninjured: 80.40 ± 13.25; injured: 73.55 ± 10.90 ms.</td>
<td>32 (20%) of the 159 participants sustained an inversion ankle sprain (0.75/1000 h of sports exposure). No significant differences were observed between the uninjured group and the ankle-sprain group for peroneal reaction time (P &gt; .05).</td>
<td>20 of the 118 participants sustained an inversion ankle sprain. The risk of sustaining an ankle sprain was 1.6/1000 h of exposure for men (14%) and 2.2/1000 h of exposure for women (19.1%). No significant differences were observed between uninjured groups and ankle-sprain groups for peroneal reaction time (P &gt; .05).</td>
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<tr>
<td>Level of evidence</td>
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<td>Conclusion</td>
<td>Peroneal reaction time was not a significant risk factor associated with ankle sprain in male physical education students.</td>
<td>Peroneal reaction time was not a significant risk factor associated with ankle sprain in female physical education students.</td>
<td>Peroneal reaction time was not a significant risk factor associated with ankle sprain in male or female college athletes.</td>
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injuries, because these interventions may modify other mechanisms that have clinical relevance beyond the scope of this CAT. It should be noted that 2 of the investigations appraised here examined muscle reaction time in other muscles including the gastrocnemius and tibialis anterior. Willems et al identified delayed gastrocnemius and tibialis anterior reaction times in injured male subjects. In addition, Beynnon et al identified trends toward faster gastrocnemius reaction time and delayed tibialis anterior reaction time in response to dorsiflexion perturbations in their injured female group. These findings suggest that future research may be warranted to explore the role of these muscles during ankle perturbations and their potential relationship to ankle sprains.

All 3 studies employed trapdoor mechanisms to create an ankle perturbation. Two studies created a perturbation combining plantar flexion and adduction to represent an ankle-sprain mechanism, and the other study created an inversion perturbation isolated to frontal-plane motion to examine peroneal reaction time. Future studies should incorporate dynamic mechanisms during gait or other sport-related activities that place the ankle in more precarious positions to prospectively explore muscle reaction times that simulate ankle-sprain mechanisms. Although delayed peroneal reaction time has been identified in individuals with a history of ankle sprain, the results of this review suggest that these alterations are not present before injury and therefore may be a neuromuscular consequence associated with ankle injuries.

Future studies should employ well-designed prospective cohort studies similar to the investigations included in this review; however, it may be worthwhile to reexamine and monitor muscle reaction time in subjects who sustain an ankle sprain. In addition, it may be useful to divide subjects into subgroups based on their level of muscle reaction time (slow, medium, fast) and examine the risk associated with injury in each group. This type of analysis may provide a more clinically relevant, patient-oriented approach for examining the relationship between muscle reaction time and ankle sprains. This CAT should be reviewed in 2 years to determine whether additional best evidence has been published that may change the bottom line for this specific question.

References