Return to Competition
Test manual for assessment of the ability to play after an acute lateral ankle sprain injury
VBG – Your statutory accident insurance provider

The VBG is a statutory accident insurance provider, insuring more than 1.1 million companies in over 100 industries across Germany – from architectural offices to temporary employment agencies. Its mandate consists of two core tasks: The first is the prevention of occupational accidents, illnesses, and health hazards. The second is fast and competent action on claims to provide optimum support for the insured person’s recovery. With nearly 490,000 reported accidents and occupational illnesses per year, the VBG supports insured persons with the goal of helping them return to work and life in the community. 2,400 VBG employees at eleven locations in Germany look after the concerns of our customers. Six VBG academies offer occupational health and safety seminars.

Further information: www.vbg.de

The solutions described in this publication do not exclude other, at least as effective solutions that may be found in the rules of other member states of the European Union, Turkey, or other signatory states of the Agreement on the European Economic Area.
Return to Competition
Test manual for assessment of the ability to play after an acute lateral ankle sprain injury
# Table of contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foreword</td>
<td>5</td>
</tr>
<tr>
<td>1 Epidemiology</td>
<td>7</td>
</tr>
<tr>
<td>2 Etiology</td>
<td>8</td>
</tr>
<tr>
<td>3 Risk factors</td>
<td>10</td>
</tr>
<tr>
<td>4 Diagnostics</td>
<td>13</td>
</tr>
<tr>
<td>5 Key phases and milestones of the rehabilitation process</td>
<td>15</td>
</tr>
<tr>
<td>6 Return to play test battery</td>
<td>17</td>
</tr>
<tr>
<td>6.1 Structure of the test battery</td>
<td>17</td>
</tr>
<tr>
<td>6.2 Exemplary warm-up</td>
<td>18</td>
</tr>
<tr>
<td>6.3 Recommendations for taping and wearing orthoses</td>
<td>18</td>
</tr>
<tr>
<td>7 Clinical examination</td>
<td>19</td>
</tr>
<tr>
<td>8 Self-reported outcome measures</td>
<td>19</td>
</tr>
<tr>
<td>8.1 Injury-Psychological Readiness to Return to Sport (I-PRRS Scale)</td>
<td>20</td>
</tr>
<tr>
<td>8.2 Cumberland Ankle Instability Tool (CAIT)</td>
<td>21</td>
</tr>
<tr>
<td>8.3 Foot and Ankle Disability Index Sport (FADI Sport)</td>
<td>23</td>
</tr>
<tr>
<td>9 Postural control</td>
<td>24</td>
</tr>
<tr>
<td>9.1 Star Excursion Balance Test (SEBT)</td>
<td>25</td>
</tr>
<tr>
<td>10 Strength</td>
<td>27</td>
</tr>
<tr>
<td>10.1 Heel Rise Test</td>
<td>28</td>
</tr>
<tr>
<td>10.2 Single-Leg Squat</td>
<td>29</td>
</tr>
<tr>
<td>11 Hop tests</td>
<td>30</td>
</tr>
<tr>
<td>11.1 Single-Leg Drop Jump</td>
<td>31</td>
</tr>
<tr>
<td>11.2 Figure of 8 Hop</td>
<td>34</td>
</tr>
<tr>
<td>11.3 Side Hop</td>
<td>35</td>
</tr>
<tr>
<td>12 Agility</td>
<td>36</td>
</tr>
<tr>
<td>12.1 T-test</td>
<td>36</td>
</tr>
<tr>
<td>13 Summary of the evaluation criteria</td>
<td>38</td>
</tr>
<tr>
<td>14 Acknowledgments</td>
<td>39</td>
</tr>
<tr>
<td>15 Bibliography</td>
<td>39</td>
</tr>
</tbody>
</table>
Foreword

Dear Readers,

The VBG’s legal mandate is to restore the health and performance of insured persons using all appropriate means. Continuing to fulfill this mandate by means of socially acceptable contributions is one of the central objectives in paid sports. We meet this challenge with a number of innovative and interdisciplinary measures in the areas of prevention as well as rehabilitation.

To this end the VBG promotes holistic sports medicine care by supporting the implementation of preventive standards and measures in sports clubs, true to the motto that after the accident is before the accident. The VBG builds awareness of responsible action among stakeholders in paid sports, especially in situations with high expectations and performance pressure.

When an injury occurs, the VBG is committed to ensuring that a return to competition is not decided solely according to a time-based assessment, but on the basis of objective criteria. This applies to certain injury categories in particular, such as ankle injuries, that are associated with extended downtime and/or a high risk of recurrence.

The VBG in cooperation with the Federal Institute of Sport Science organized a consensus conference “Return to Competition after Ankle Injuries” with the goal of bundling the existing expertise of the professions involved in the rehabilitation process. Participants included research groups, sports scientists, doctors, physiotherapists, and athletics and rehabilitation coaches. We would like to take this opportunity to express our sincere appreciation to the Federal Institute of Sport Science and all participants.

With this publication, the VBG is now making the results of the consensus conference available to you. An innovative test battery takes center stage. It helps you objectively assess whether a player with an ankle injury is ready to return to full, unrestricted team training. On the following pages, you will also find a wealth of further information about the causes and diagnosis of acute lateral ankle sprain injuries.

You will find further information and media, especially for prevention and return to competition, on the VBG sports page under www.vbg.de/sport.

With kind regards

Hendrik Bloch
Project Manager
1 Epidemiology

Ankle injuries are among the most frequent sports injuries, with a high risk of recurrence. In fact, ankle injuries ranked first at 18.6 percent in basketball for the 2016/17 season. A summary of current studies shows that some 70 to 80 percent of athletes, after a primary ankle injury, get injured on the ankle again. The lateral ligamentous apparatus is most often affected. More than two thirds of all ankle injuries are classified as sprains. The VBG Sports Report 2017 in part confirms this situation. While sprains rank highest in the sports that were investigated – basketball, ice hockey, soccer, and handball – the proportion varies considerably. In basketball (73.3 percent) and handball (61.6 percent), the information in the literature is confirmed, but in soccer only slightly more than half (56.2 percent) and in ice hockey only slightly more than one third (36.4 percent) of all ankle injuries can be classified as sprains.

Ankle injuries in elite team sports

Figure 1: Percentage of ankle injuries in the sports of basketball, ice hockey, soccer, and handball in the 2016/17 season, 1st/2nd men’s league

1 Hertel 2002, Best et al. 2016
2 Friel et al. 2006, Clanton et al. 2012, Hertel 2002
2 Etiology

70–85 percent of ankle injuries occur in the course of inversion/supination trauma. Examining the most common movement patterns at the time of the injury shows that ankle injuries occur primarily after the initial contact while running or at the moment of landing after a jump. Increased plantar flexion during initial contact further increases the probability of a lateral ankle sprain.

Lateral ankle sprain injuries are also associated with delayed reaction time of the peroneal muscles at the lateral aspect of the ankle (after approx. 60–90 ms), with the maximum deflection of an uninjured, stable ankle already being reached at about 40° (after 70 ms).

According to the etiological analysis of injuries, three main mechanisms can be differentiated: non-contact, indirect contact and contact. While contact is the dominant injury mechanism for ankle injuries, an opposing foul is a contributing cause in only every fifth to ninth injury across all sports (see Figure 2 and 3).

6 Fong et al. 2009
7 Best et al. 2016
Injury mechanisms on the ankle

<table>
<thead>
<tr>
<th>Sport</th>
<th>Non-contact</th>
<th>Indirect Contact</th>
<th>Contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basketball</td>
<td>74.6%</td>
<td>16.7%</td>
<td>8.0%</td>
</tr>
<tr>
<td>Ice Hockey</td>
<td>44.4%</td>
<td>29.5%</td>
<td>18.7%</td>
</tr>
<tr>
<td>Soccer</td>
<td>62.5%</td>
<td>38.9%</td>
<td>8.0%</td>
</tr>
<tr>
<td>Handball</td>
<td>62.7%</td>
<td>18.6%</td>
<td>18.6%</td>
</tr>
</tbody>
</table>

Figure 2: Percentage of contact, indirect contact, and non-contact injuries in basketball, ice hockey, soccer, and handball in the 2016/17 season, 1st/2nd men’s league

Source: VBG-Sportreport 2018

Foul as the cause of injury, by sport

<table>
<thead>
<tr>
<th>Sport</th>
<th>Opposing Foul</th>
<th>Own Foul</th>
<th>No Foul</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basketball</td>
<td>80.2%</td>
<td>83.3%</td>
<td>11.5%</td>
</tr>
<tr>
<td>Ice Hockey</td>
<td>16.7%</td>
<td>22.9%</td>
<td>8.3%</td>
</tr>
<tr>
<td>Soccer</td>
<td>63.8%</td>
<td>13.3%</td>
<td>16.7%</td>
</tr>
<tr>
<td>Handball</td>
<td>78.0%</td>
<td>3.4%</td>
<td>18.6%</td>
</tr>
</tbody>
</table>

Figure 3: Percentage no foul, own foul, and opposing foul for ankle injuries in the sports of basketball, ice hockey, soccer, and handball in the 2016/17 season, 1st/2nd men’s league

Source: VBG-Sportreport 2018
3 Risk factors

Risk factors can be divided into the categories of internal and external factors. Note that the former in particular include factors that can be influenced.

Yet factors that can be influenced, such as equipment elements, are found among the external risk factors as well. This suggests a fundamental prevention potential for sports injuries in general. However, the prevalence of one or more risk factors does not per se lead to an injury. An inciting event is needed in addition.

The more risk factors exist and the more severe they are, the lower the tolerance against incidents that occur will be.

However, an injury can also occur when there are no discernible risk factors if the effect of the occurring incident is great enough. Key risk factors for ankle injuries are:

- **Previous injuries**
  - Greatest risk factor for a recurrent injury.\(^8\)
  - A previous injury also increases the risk of a contralateral subsequent injury.\(^3\)

- **Fatigue**
  - Ankle injuries occur less frequently at the start of the game. This indicates that fatigue influences the occurrence of an injury.\(^9\)
  - Fatigue reduces postural control, especially for players with previous ankle injuries.\(^10\)

- **Reduced postural control**
  - Reduced postural control increases the risk of ankle injury.\(^11\)

![Risk factor model](image)

**Figure 4: Risk factor model for sports injuries (Windt & Gabbett 2016)**
In turn, ankle injuries have a negative effect on postural control.13

Improper load management
- Load management has a direct influence on the risk of injury. For example, inappropriate spikes in workload can increase the risk of injury.14

Strength deficits
- Strength deficits and delayed reaction times (eccentric/concentric) of ankle inversion and eversion muscles increase the risk of ankle injury.15
- Athletes with hip abductor weakness have a higher risk of suffering a non-contact ankle injury.16

Limited mobility
- Reduced or limited dorsiflexion and ipsilateral plantar flexion increase the risk of ankle sprain injury.15 18

Disturbed proprioception
- Ankle injuries have a negative effect on proprioception, which increases the risk of recurrent injury.19

Acute:chronic workload ratio

The acute:chronic workload ratio should be taken into account in particular during the rehabilitation process and in the return to play decision. Here the acute workload for the past week is compared to the workload in the medium term, for example the previous 4 weeks (“chronic workload”). In the interest of training management for the purpose of injury prevention, this rolling ratio should be in the range of 0.8 to 1.3. In soccer this ratio should be in the range of 1.0 to 1.25 in order to avoid injuries due to disproportionate spikes in workload.

Ultimately the prerequisites for full participation in team training and a return to competition can be established through a meaningful progression of the workload and intensity.20
Example:
The athlete, upon returning to unrestricted team training, completes a normal training week with a training load of 100 percent (“acute workload”).

But if the athlete’s average training load during the previous four weeks in rehabilitation training due to the injury was only 40 percent (“chronic workload”), the probability of injury for the coming week is 28 percent (see Figure 6). The training load can be calculated as follows:

\[
\text{training load} = \text{training duration} \times \text{RPE (rating of perceived exertion)}
\]

For example:

\[
\begin{align*}
\text{training duration} &= 90 \text{ minutes} \\
\text{RPE} &= 7 \\
\text{training load} &= 90 \times 7 = 630
\end{align*}
\]
4 Diagnostics

When an athlete suffers an injury, a precise and differentiated diagnosis is essential to initiate optimal treatment. Conservative treatment is appropriate for the majority of lateral ankle sprain injuries. However, the possible need for surgical stabilization can also be determined in the course of diagnosis. In case of lasting instability in the ankle (at least 3 months), the diagnosis should differentiate between mechanical instability (ligament insufficiency) and functional instability (muscular/proprioceptive deficit). The following diagnostic focal points have established themselves for acute lateral ankle injuries: 21

**Inspection**
- Perception of pain
- Swelling/hematoma
- Gait pattern

**Palpation**
- Palpation should include the following areas: lateral malleolus, course of the ligaments, joint capsule, syndesmosis, peroneal tendon insertion, retinaculum, medial malleolus, course of the deltoid ligament, head of the fibula, fifth metatarsal bone.

**Functional and pain tests**
- Swelling and pain reduce reliability in the acute phase. That is why a time-delayed examination is recommended (4–5 days after the trauma). Then the sensitivity for correct diagnosis of a lateral ligament rupture is 96 percent with a specificity of 84 percent.

**Examinations using instruments and equipment**
- The added diagnostic value of examinations using instruments and equipment always has to be reviewed on a case-by-case basis. At the latest when complaints continue for > 5 days, an MRT is usually required to exclude concomitant injuries (in particular osteochondral lesions).
- Stress X-rays are generally not recommended.

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21 Rammelt et al. 2017, Loeffen et al. 2018
The **Ottawa Ankle Rules** are recommended for the clinical exclusion of fractures. They supply important information to determine the need for an X-ray. This is indicated only if the patient
- cannot walk four steps directly after the injury occurs, or
- perceives increased local bone sensitivity in the area of the rear malleolus edges or tips (4 palpation points), or
- perceives increased local bone sensitivity in the area of the os naviculare or base of the fifth metatarsal bone.

The GOTS (Society for Orthopaedic Traumatologic Sports Medicine) nevertheless recommends that taking an X-ray should be mandatory to exclude a concomitant bone injury.\(^\text{12}\)

If chronic ankle instability is suspected in the course of treatment and rehabilitation, the algorithm shown in Figure 8 can be used to aid decision-making.
5 Key phases and milestones of the rehabilitation process

**Pre-injury screening (PRE)**
A pre-injury screening is a prospective data collection that provides the rehabilitation staff with important reference values for the injured athlete that can be used in the event of an injury. Moreover, individual baseline values from pre-injury screenings are superior to the frequently used limb symmetry index (LSI) or data from reference populations. Besides its value in the rehabilitation process, a pre-injury screening offers the opportunity to identify individual performance deficits. This may be helpful to regulate the training process and to derive targeted individual primary prevention measures before an injury occurs.

**Return to activity (RTA)**
Return to activity is the transition from clinical care (phase I) to general rehabilitation training (phase II) and describes the first post-traumatic milestone the injured athlete is able to achieve. After the injury, the athlete passes a clinical examination by a physician who decides whether the athlete is able to start the general rehabilitation training, which then mainly focuses on regaining range of motion, stability, and movement control during basic movement patterns.

**Return to sport (RTS)**
Return to sport marks the starting point of the crucial rehabilitation phase (phase III) from the inclusion of the sport-specific rehabilitation training (phase IIIA) to the individualized team training (phase IIIB). At the return to sport milestone, the athlete should already meet basic clinical and functional requirements as a result from the previous rehabilitation phase. After passing the RTS milestone, the rehabilitation program becomes increasingly sport specific. In later stages and with advancing athlete performance, growing parts of the rehabilitation content take place under sport specific conditions. This phase should be developed progressively and is normally instructed through athletic coaches, rehabilitation coaches, as well as physiotherapists. It is important to consider whether the sports-specific exercises can be performed by the athlete in a coordinated manner and if they can be tolerated by the injured structure without clinical symptoms such as swelling or pain occurring. Frequently, this phase is also described as a return to restricted team training, since body contact is still deliberately omitted and the athlete participates in team training only partially or modified (i.e., by special identification of the athlete).

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**Figure 9: Phases in the rehabilitation process**

PRE = pre-injury screening, RTA = return to activity, RTS = return to sport, RTP = return to play, RTC = return to competition
**Return to play (RTP)**

Return to play refers to the successful transition from individualized and restricted team training to unrestricted participation in team and competition training. The VBG defines this milestone as the end of short-term disability for work. Thus, an interdisciplinary (i.e., sports physician, physiotherapists, athletic coaches, rehabilitation coaches, sports psychologists) decision making by means of a comprehensive test battery is essential to promote to unrestricted participation in competitive training. In the light of the collected findings, the return to play decision has to be ultimately made by the responsible team physician.

**Return to competition (RTC)**

On the one hand, the return to competition milestone describes the first participation in a competitive match, which is finally the athlete’s main goal. On the other hand, return to competition also indicates the entire reintegration process from the time of the injury to the first match play. The time span from the positive return to play decision and the athlete's first selection for a competitive match is the only decision that may primarily lie in the head coach’s responsibility. But it is recommended that he comes to an agreement with his medical and therapeutic staff as well as the athlete himself to make a responsible decision.

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**Figure 10: Key milestones in the rehabilitation process**

- **PRE**
  - Pre-injury screening = Baseline testing for individual reference data

- **RTA**
  - Return to activity = Progression to unspecific rehabilitation

- **RTS**
  - Return to sport = Progression to sport-specific rehabilitation

- **RTP**
  - Return to play = Progression to unrestricted team training

- **RTC**
  - Return to competition = first participation in a competitive match
6 Return to play test battery

6.1 Structure of the test battery

An RTP-decision should be made based on subjective and objective criteria (quantitative and qualitative) with a functional test component.\textsuperscript{23, 24}

The technical literature lists the following criteria as examples: unrestricted mobility, 90 percent of the strength values achieved before the injury, a normal gait pattern, and the ability to complete movements specific for the sport without compensation.\textsuperscript{24}

Building on that, the expert group established the test categories shown in Figure 11:

The test battery is a concluding decision-making aid to evaluate the test person’s ability to participate in competition training again with no restrictions (return to play milestone). Here the diagnosis results should be used as the basis for interdisciplinary discussion between the professions taking part in the rehabilitation process. However, they are not a replacement for preceding test procedures for optimal management of the rehabilitation process. If complaints occur during testing, this has to be considered an abort criterion.

The schematic representation of the test battery shows the time sequence of the test categories. The minimum standard is described within each test category. Cut-off values and/or orientation values from the technical literature are listed for each test to assist with classification of the test results. They help to better assess the capabilities of the injured test person, but without claiming predictive significance regarding the recurrence of injury.

Before testing, the test person’s leg dominance should be determined. The leg that the test person would preferably use to kick a ball is considered the dominant leg.

\textsuperscript{23} Clanton et al. 2012
\textsuperscript{24} Kaminski et al. 2013
\textsuperscript{25} Chinn et al. 2010
6.2 Exemplary warm-up

Having the test person complete an appropriate warm-up before performing the test battery is required. This can for example include the following elements:

- Running on a treadmill with increasing intensity:
  - 2 minutes easy running at 8.0 km/h
  - 3 minutes increased intensity at 10.0 km/h
  - 3 minutes increased intensity at 12.0 km/h
  - 2 minutes easy running at 8.0 km/h

  **Hint:** The warm-up on the treadmill can be used for a qualified running analysis.

- Mobilization exercises (hip, knee, and ankle joint for example)
- Trunk stabilization exercises
- Balance exercises on one leg (with perturbation)
- Knee bending exercises (varying speed of execution)
- Jumping and landing training (for example squat jumps, counter movement jumps, lateral bounds, or reactive jumps)
- Dynamic direction change (for example 45°, 90°, 180°) with subsequent action

→ If complaints occur during the warm-up, this is considered an abort criterion for completing the test battery.

You will find appropriate warm-ups in the VBG training exercises

6.3 Recommendations for taping and wearing orthoses

Testing should generally be carried out without tape or an orthosis in order to measure the athlete’s actual performance and not mask possible deficits. If the athlete being tested always trains or plays with tape or an orthosis anyway, RTP testing before returning to unrestricted team training can also be performed under these conditions.

→ Using tape or an orthosis for all training and games is recommended for athletes during a period of at least 6 months after an ankle injury to minimize the risk of recurrence. The decreasing effectiveness of ankle tape in the course of training or a game has to be considered → This means re-taping is essential.26

**Background:**

- An orthosis significantly reduces the risk of ankle injuries, especially for previously injured athletes.27
- Tapes and orthoses are considered effective to reduce recurrent ankle injuries.28
- Orthoses with lacing appear to exhibit better dynamic stability than orthoses without lacing.29

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28 Shaw et al. 2008
29 Best et al. 2014
7 Clinical examination

Clinical examination has to cover the following aspects:
• Analgesia
• No swelling (swelling has largely gone down, and no increase in swelling during or after load application)
• No elevated skin temperature
• Negative clinical tests (for example anterior drawer test, talar tilt test, squeeze test)
• Unrestricted active and passive mobility, equal on both sides as far as possible (for example knee to wall test)
• Active control of peroneus muscles
• Exclusion of relevant, persistent mechanical instability

8 Self-reported outcome measures

Why this test category?
• The personal perception of the athlete’s own body should be part of a return to play decision.30
• Mental factors influence the risk of injury and recurrent injury.31

What tests should be performed as a minimum?
• Cumberland Ankle Instability Tool (CAIT)
• Injury-Psychological Readiness to Return to Sport Scale (i-PRRS Scale)
• Foot and Ankle Disability Index Sport Items (FADI Sport)

30 Kaminski et al. 2013
31 Junge 2000, Ortín Montero et al. 2010
8.1 Injury-Psychological Readiness to Return to Sport (I-PRRS Scale)\textsuperscript{32}

The I-PRRS Scale measures an athlete's self-confidence after an injury and therefore helps assess whether they are mentally ready for a return to the target sport.

**Objective:**
Verifying mental readiness for a return to competition

**Materials required:**
- Questionnaire
- Writing materials

**Performing the test**

Please rate your confidence to return to your sport on a scale from 0–100.
0 = no confidence at all, 50 = moderate confidence, 100 = complete confidence

<table>
<thead>
<tr>
<th>Rate</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>My overall confidence to play is</td>
<td></td>
</tr>
<tr>
<td>My confidence to play without pain is</td>
<td></td>
</tr>
<tr>
<td>My confidence to give 100 percent effort is</td>
<td></td>
</tr>
<tr>
<td>My confidence to not concentrate on the injury is</td>
<td></td>
</tr>
<tr>
<td>My confidence in the injured body part to handle to demands of the situation is</td>
<td></td>
</tr>
<tr>
<td>My confidence in my skill level/ability is</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
</tr>
</tbody>
</table>

**Measurement:**
Add total and divide by 10.

**Assessment and orientation values:**
- 60 = high confidence
- 40 = moderate confidence
- 20 = low confidence

Scores between 50 and 60 suggest the athlete is psychologically ready to return to sports. Scores below 50 suggest that the athlete may not be ready psychologically to return to sports and needs more time to recover.

\textsuperscript{32} Glazer 2009, Clanton et al. 2012

www.vbg.de/IPRRS-Scale
8.2 Cumberland Ankle Instability Tool (CAIT)\textsuperscript{33}

The CAIT inquires about specific restrictions following ankle sprain trauma.

**Objective:** Subjective assessment of ankle stability

**Materials required:**
- Questionnaire
- Writing materials

### Performing the test

Please check off the statement that BEST describes your ankles. Evaluate your ankles separately and give one answer respectively for the LEFT and RIGHT.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Left</th>
<th>Right</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>I have pain in my ankle</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never</td>
<td>☐</td>
<td>☐</td>
<td>5</td>
</tr>
<tr>
<td>During sport</td>
<td>☐</td>
<td>☐</td>
<td>4</td>
</tr>
<tr>
<td>Running on uneven surfaces</td>
<td>☐</td>
<td>☐</td>
<td>3</td>
</tr>
<tr>
<td>Running on level surfaces</td>
<td>☐</td>
<td>☐</td>
<td>2</td>
</tr>
<tr>
<td>Walking on uneven surfaces</td>
<td>☐</td>
<td>☐</td>
<td>1</td>
</tr>
<tr>
<td>Walking on level surfaces</td>
<td>☐</td>
<td>☐</td>
<td>0</td>
</tr>
<tr>
<td><strong>My ankle feels UNSTABLE</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never</td>
<td>☐</td>
<td>☐</td>
<td>4</td>
</tr>
<tr>
<td>Sometimes during sport (not every time)</td>
<td>☐</td>
<td>☐</td>
<td>3</td>
</tr>
<tr>
<td>Frequently during sport (every time)</td>
<td>☐</td>
<td>☐</td>
<td>2</td>
</tr>
<tr>
<td>Sometimes during daily activity</td>
<td>☐</td>
<td>☐</td>
<td>1</td>
</tr>
<tr>
<td>Frequently during daily activity</td>
<td>☐</td>
<td>☐</td>
<td>0</td>
</tr>
<tr>
<td><strong>When I make SHARP turns, my ankle feels UNSTABLE</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never</td>
<td>☐</td>
<td>☐</td>
<td>3</td>
</tr>
<tr>
<td>Sometimes when running</td>
<td>☐</td>
<td>☐</td>
<td>2</td>
</tr>
<tr>
<td>Often when running</td>
<td>☐</td>
<td>☐</td>
<td>1</td>
</tr>
<tr>
<td>When walking</td>
<td>☐</td>
<td>☐</td>
<td>0</td>
</tr>
<tr>
<td><strong>When going down the stairs, my ankle feels UNSTABLE</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never</td>
<td>☐</td>
<td>☐</td>
<td>3</td>
</tr>
<tr>
<td>If I go fast</td>
<td>☐</td>
<td>☐</td>
<td>2</td>
</tr>
<tr>
<td>Occasionally</td>
<td>☐</td>
<td>☐</td>
<td>1</td>
</tr>
<tr>
<td>Always</td>
<td>☐</td>
<td>☐</td>
<td>0</td>
</tr>
<tr>
<td><strong>My ankle feels UNSTABLE when standing on ONE leg</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never</td>
<td>☐</td>
<td>☐</td>
<td>2</td>
</tr>
<tr>
<td>On the ball of my foot</td>
<td>☐</td>
<td>☐</td>
<td>1</td>
</tr>
<tr>
<td>With my foot flat</td>
<td>☐</td>
<td>☐</td>
<td>0</td>
</tr>
<tr>
<td><strong>My ankle feels UNSTABLE when</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never</td>
<td>☐</td>
<td>☐</td>
<td>3</td>
</tr>
<tr>
<td>I hop from side to side</td>
<td>☐</td>
<td>☐</td>
<td>2</td>
</tr>
<tr>
<td>I hop on the spot</td>
<td>☐</td>
<td>☐</td>
<td>1</td>
</tr>
<tr>
<td>When I jump</td>
<td>☐</td>
<td>☐</td>
<td>0</td>
</tr>
</tbody>
</table>

## Return to Competition – Lateral Ankle Sprain

### Measurement:

The questionnaire is filled out for each leg. The assessment system in the right-hand column is not visible to the person filling out the questionnaire. Points for the individual items are summed. The maximum total number of points is 30.

<table>
<thead>
<tr>
<th>My ankle feels UNSTABLE when</th>
<th>Left</th>
<th>Right</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td>☐</td>
<td>☐</td>
<td>4</td>
</tr>
<tr>
<td>I run on uneven surfaces</td>
<td>☐</td>
<td>☐</td>
<td>3</td>
</tr>
<tr>
<td>I jog on uneven surfaces</td>
<td>☐</td>
<td>☐</td>
<td>2</td>
</tr>
<tr>
<td>I walk on uneven surfaces</td>
<td>☐</td>
<td>☐</td>
<td>1</td>
</tr>
<tr>
<td>I walk on a flat surface</td>
<td>☐</td>
<td>☐</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TYPICALLY, when I start to roll over (or “twist”) on my ankle, I can stop it</th>
<th>Left</th>
<th>Right</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immediately</td>
<td>☐</td>
<td>☐</td>
<td>3</td>
</tr>
<tr>
<td>Often</td>
<td>☐</td>
<td>☐</td>
<td>2</td>
</tr>
<tr>
<td>Sometimes</td>
<td>☐</td>
<td>☐</td>
<td>1</td>
</tr>
<tr>
<td>Never</td>
<td>☐</td>
<td>☐</td>
<td>0</td>
</tr>
<tr>
<td>I have never rolled over on my ankle</td>
<td>☐</td>
<td>☐</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>After a TYPICAL incident of my ankle rolling over, my ankle returns to “normal”</th>
<th>Left</th>
<th>Right</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Almost immediately</td>
<td>☐</td>
<td>☐</td>
<td>3</td>
</tr>
<tr>
<td>Less than one day</td>
<td>☐</td>
<td>☐</td>
<td>2</td>
</tr>
<tr>
<td>1–2 days</td>
<td>☐</td>
<td>☐</td>
<td>1</td>
</tr>
<tr>
<td>More than 2 days</td>
<td>☐</td>
<td>☐</td>
<td>0</td>
</tr>
<tr>
<td>I have never rolled over on my ankle</td>
<td>☐</td>
<td>☐</td>
<td>3</td>
</tr>
</tbody>
</table>

### Assessment and orientation values:

If an athlete scores a total of fewer than 28 points, the likelihood of chronic ankle instability is increased. A total ≤ 24 is considered an inclusion criterion for chronic ankle instability.

---

35 Gribble et al. 2014

www.vbg.de/CAIT
8.3 Foot and Ankle Disability Index Sport (FADI Sport)\textsuperscript{36}

The FADI Sport is a practical tool to identify functional impairments that are subjectively perceived by the test person after an ankle injury.

**Objective:**
Subjective assessment of ankle stability

**Materials required:**
- Questionnaire
- Writing materials

### Performing the test

<table>
<thead>
<tr>
<th>FADI Sport item</th>
<th>unable to do</th>
<th>extreme difficulty</th>
<th>moderate difficulty</th>
<th>slight difficulty</th>
<th>no difficulty at all</th>
</tr>
</thead>
<tbody>
<tr>
<td>Running</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jumping</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Landing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Squatting and stopping quickly</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cutting, lateral movements</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low-impact activities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ability to perform activity with your normal technique</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ability to participate in your desired sport as long as you would like</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Measurement:

The questionnaire is filled out by the test person and refers to their current state. Subjects rate the activity as no difficulty at all (4 points), slight difficulty (3 points), moderate difficulty (2 points), extreme difficulty (1 point), unable to do (0 points), or N/A (not applicable). For pain related to the foot and ankle, subjects select no pain (4 points), mild (3 points), moderate (2 points), severe (1 point), or unbearable (0 points). Points for the individual items are summed. The maximum total number of points is 32.

**Assessment and orientation values:**
The test person should score a total of at least 29 points (90 percent).

### Monitoring the perceived physical condition

The perceived physical condition should be monitored to obtain a regular overview of the athlete’s subjective state regarding the injured ankle during rehabilitation. Ideally this should be recorded daily, before and after each (rehabilitation) training unit. The fear of a recurrent injury can for example be checked with the somewhat more extensive Re-Injury Anxiety Inventory (RAI).\textsuperscript{37}

<table>
<thead>
<tr>
<th></th>
<th>Right now the injured part of my body feels like this</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy factor</td>
<td>Full of energy, activated</td>
</tr>
<tr>
<td>Conditioning factor</td>
<td>Strong, powerful, fit, conditioned</td>
</tr>
<tr>
<td>Mobility factor</td>
<td>Flexible, resilient, agile</td>
</tr>
<tr>
<td>Health factor</td>
<td>Healthy, well</td>
</tr>
</tbody>
</table>

Figure 12: Perceived physical condition scale (Kleinert 2003)
9 Postural control

Why this test category?
- Weak postural control is considered a risk factor for ankle injuries. 38
- In turn, ankle injuries have a negative effect on postural control. This applies for both the affected and the unaffected side. 39
- Fatigue reduces postural control, especially for players with previous ankle injuries. 40

What test should be performed as a minimum?
- Star Excursion Balance Test (SEBT)

With the corresponding test kit, this test can also be carried out as the Y Balance Test®.

Postural control can be tested within the framework of computer-aided posturography as well. To represent interference factors typical for the game, testing can additionally take place with perturbation.

38 McKeon & Hertel 2008, Witchalls et al. 2013
39 McKeon & Hertel 2008
40 Steib et al. 2013, Greig & McNaughton 2014
9.1 Star Excursion Balance Test (SEBT)\textsuperscript{41}

Studies have shown that athletes with deficits in the SEBT exhibit an increased risk of lower limb injury. This test challenges the athlete in regards to strength in the lower limbs, balance skills, and mobility. It uncovers the athlete’s postural control deficits, which in turn are considered a risk factor for ankle injuries.

**Objective:**
- Checking postural control
- Uncovering asymmetries between the sides

**Materials required:**
- Tape
- Measuring tape
- Measuring record
- Marking template

**Performing the test**

First the leg length is measured as a reference value (see info box on page 26). The test person stands barefoot with the hands on the hips in the middle of the Y and moves the non-supporting leg as far forward (anterior) as possible (A). Initially the supporting leg is the uninjured leg. The heel of the supporting leg has to remain on the floor and the non-supporting leg may not touch the floor while performing the movement, and both hands have to remain on the hips for the entire test duration.

The specific testing order is:
1. Uninjured leg anterior reach (3 trials)
2. Injured leg anterior reach (3 trials)
3. Uninjured posteromedial reach (3 trials)
4. Injured posteromedial reach (3 trials)
5. Uninjured posterolateral reach (3 trials)
6. Injured posterolateral reach (3 trials)

The non-supporting leg may be set down after each direction is measured, so the test person can start the respective next measurement from a stable, balanced position.

The point farthest from the middle of the Y, where the position can be held for three seconds without touching the floor, is measured for each direction of movement.

Due to short-term learning effects, three practice runs are first performed with each leg and direction, followed by three tests for each leg and direction that are evaluated. The best test result for each leg and direction is used.

![Figure A (anterior)](image1)
![Figure B (posteromedial)](image2)
![Figure C (posterolateral)](image3)

Figure 13: Star Excursion Balance Test for the lower limbs

Figure 14: Marking template for the Star Excursion Balance Test

\textsuperscript{41} Plisky et al. 2006, Gribble et al. 2012, Gonell et al. 2015; Grassi et al. 2017
Return to Competition – Lateral Ankle Sprain

Measurement:
A composite score is calculated for each leg by taking the sum of the reach distances (in centimeter) in the three directions (Figure A, B, C), divided by three times the leg length then multiplied by 100.

\[
\text{Composite score} = \frac{(\text{Reach Fig. A} + \text{Reach Fig. B} + \text{Reach Fig. C}) \times 100}{3 \times \text{leg length}}
\]

To make the results (reach distances) comparable between different test persons or groups of test persons, the ranges have to be standardized for the leg length.

Assessment and orientation values:
The composite score should be at least 94 percent and viewed in comparison between the legs. Furthermore, the difference between the legs for each direction of movement (anterior, posteromedial, posterolateral) should not exceed 4 centimeters.

The leg length is measured in the supine position, from the anterior superior iliac spine to the medial malleolus.
10 Strength

Why this test category?

• An ankle injury causes strength deficits and delayed reactions (eccentric/concentric) of the eversors and inversors.\textsuperscript{42}

• Test persons with functional ankle instability do not perform as well in isokinetic strength tests as test persons with stable ankles.\textsuperscript{43}

• Dynamic strength imbalances and reduced EMG activity of the eversors and inversors compared to healthy athletes are seen in test persons with chronic ankle instability.\textsuperscript{44}

• Demands on the plantar flexors are high even during normal walking. This applies in particular from the end of the loading response (LR) to the terminal stance (TST), since the calf actively contracts during 90 percent of this time, and for more than 50 percent at peak activity.\textsuperscript{45}

• Plantar flexor deficits are seen in the affected leg after an ankle injury.\textsuperscript{46}

What tests should be performed as a minimum?

• Heel Rise Test
• Single-Leg Squat

An isokinetic strength test, which should be performed with slow angular velocities, is currently recommended as the gold standard.\textsuperscript{47}

→ Plantar flexor/dorsal extensor isokinetics: Concentric/eccentric, 60° angular velocity \textsuperscript{48}

→ Eversor and inversor isokinetics: 60° angular velocity \textsuperscript{49}

\textsuperscript{43} Arnold et al. 2009
\textsuperscript{44} David et al. 2013
\textsuperscript{45} Götz-Neumann 2016, Svantesson et al. 2015
\textsuperscript{46} Perron et al. 2014
\textsuperscript{47} Arnold et al. 2009
\textsuperscript{48} Fousekis et al. 2012
\textsuperscript{49} Pontaga 2004
10.1 Heel Rise Test

The heel rise test records the eccentric and concentric muscle strength of the plantar flexors when the heel is lifted while standing on one leg.

**Objective:**
- Checking the strength of the plantar flexors
- Checking the hindfoot movement
- Checking the ground contact of the first metatarsophalangeal joint (MTP I)

**Materials required:**
- Metronome
- Measuring record
- Video documentation if applicable

**Performing the test**

The test person is barefoot and stands on one leg. They may touch the wall with one finger of each hand. The test is performed with the knee joint extended. The other leg is lifted towards the rear with the knee bent. The test person lifts the heel in a controlled manner to the maximum possible range of motion and then lowers it, also in a controlled manner. After setting down the heel, it is lifted again. The test should be standardized using a metronome (lift heel every 2 seconds).

**Measurement:**
The number of repetitions per side is counted.

**Assessment and orientation values:**
The number of repetitions per side is noted. A comparison between the sides is performed in addition. At least 30 repetitions is the target value.

The quality of execution should be assessed as well (for example: forefoot stays in contact with the floor, continuous and controlled execution of movement).

---

10.2 Single-Leg Squat

Athletes with hip abductor weakness exhibit reduced medial-lateral postural control. This in turn is considered a risk factor for an ankle injury.

Hip abductor weakness is often exhibited as the result of an ankle injury, making it necessary to check this as part of the return to play assessment.

**Objective:**
- Checking the movement quality of a single-leg squat in order to draw conclusions about the strength of the hip abductors
- Uncovering muscular deficits that may lead to asymmetries and compensating movement patterns

**Materials required:**
- Bench/stool
- Video camera
- Measuring record

**Performing the test**

Standing on one leg on a bench or box, both arms are crossed in front of the chest. One leg is slightly forward. A single-leg squat is executed from this position, to the individual maximum knee flexion. 5 single-leg squats are executed in sequence on each side, slowly and in a controlled manner (1 knee bend = approx. 2 seconds) while maintaining balance. The supporting leg maintains full ground contact during execution. Pay special attention to the heel, which must not be raised. Video documentation of the test is prepared so that possible inaccuracies during test execution in the frontal and sagittal planes are easier to identify.

**Measurement:**
Video documentation of the execution of the single-leg squat is prepared from the front (frontal plane) and the side (sagittal plane). Then the movement quality is evaluated in five assessment categories using the assessment form while studying the video.

**Assessment and orientation values:**
The execution of the single-leg squat should earn an assessment of “good”. Here the following criteria have to be met:

---

1. Overall Impression

<table>
<thead>
<tr>
<th>Good</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Smooth, good-quality movement</td>
<td>• Staggered movement</td>
</tr>
<tr>
<td>• General control</td>
<td>• Increased speed to attempt to control movement</td>
</tr>
<tr>
<td>• Controlled change-over between repetitions</td>
<td>• Effort to control movement</td>
</tr>
<tr>
<td>• Ease of movement</td>
<td>• Trunk „wobble“</td>
</tr>
</tbody>
</table>

2. Weight Transfer

<table>
<thead>
<tr>
<th>Good</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Minimal translation of center of mass</td>
<td>• Discernible translation of center of mass</td>
</tr>
<tr>
<td>• Upright trunk</td>
<td>• Trunk leaning forward or to side</td>
</tr>
<tr>
<td></td>
<td>• Extended time to transfer</td>
</tr>
</tbody>
</table>

3. Lumbar Spine and Pelvic Alignment

<table>
<thead>
<tr>
<th>Good</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Minimal movement on all three planes</td>
<td>• Discernible movement with pelvis tilting up or down, rotating toward or away from weight bearing leg, tilting in anterior or posterior direction</td>
</tr>
<tr>
<td>• Frontal plane: ASIS level</td>
<td>• Lumbar lordosis increasing or trunk flexion occurring</td>
</tr>
<tr>
<td>• Sagittal plane: minimal A-P tilt, rotation</td>
<td></td>
</tr>
<tr>
<td>• Lateral view: stable lordosis, minimal trunk flexion</td>
<td></td>
</tr>
</tbody>
</table>

4. Leg Alignment

<table>
<thead>
<tr>
<th>Good</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Minimal movement out of the starting plane movement. This takes into account the alignment of the limb, influenced by pelvic width, and Q angle at the knee</td>
<td>• Discernible movement out of the starting plane of movement</td>
</tr>
</tbody>
</table>

5. Foot Alignment

<table>
<thead>
<tr>
<th>Good</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Neutral foot position – remains stable during movement</td>
<td>• Excessive pronation of foot during squat descent</td>
</tr>
<tr>
<td></td>
<td>• Externally rotated starting position of lower leg/foot</td>
</tr>
</tbody>
</table>

Table 1: Rating criteria for single-leg squat (Perrot et al. 2012)

11 Hop tests

**Why this test category?**
- Jumping power is a determining factor for sports performance. At the same time, landing after a jump is among the situations with the highest risk of injury in team sports. Landing quality deficits are often seen in athletes with an ankle injury. These for example take the form of reduced stabilization or altered ankle, knee, and hip angles.52

**What tests should be performed as a minimum?**
- Single-Leg Drop Jump
- Figure of 8 Hop
- Side Hop

**Limb Symmetry Index (LSI)**

- For hop tests where height, distance, or repetitions are measured, meaning that a higher value implies a better result, the LSI is calculated as follows:
  \[ \text{LSI} = \text{injured side/uninjured side} \times 100 \]
- For hop tests where times are measured, meaning that a lower value implies a better result, the LSI is calculated as follows:
  \[ \text{LSI} = \text{uninjured side/injured side} \times 100 \]

---

11.1 Single-Leg Drop Jump

The drop jump (DJ) is a reactive jump, down and then up, from a specified height. With the DJ, the reactive strength of the legs is determined with very brief eccentric/concentric power development, that is by utilizing a brief stretch-shortening cycle (< 250 milliseconds).

**Objective:**
- Checking the reactive leg extension strength
- Measuring the jump height
- Assessing the movement quality

**Performing the test**

Shoes are worn for the test. The test person stands on one leg on a 20 centimeter raised platform. The hands are at the sides on the hips (when markers or inertial sensors are used, the hands are placed behind the head). The test person is instructed to let themselves fall off the box by taking a step forward, without jumping. Ground contact during the landing phase should be as brief as possible, while the test person tries to jump up off the floor as high as possible on one leg. The upper body should be kept as straight as possible and the contralateral leg is not permitted to touch the floor.

An attempt is not counted if any of these movement characteristics are not met. The jump is carried out per side, once as a trial (80 percent of maximum performance) and three times as a measured test. Start with the uninjured leg. The best attempt is assessed.

**Measurement:**

The jump height in centimeters is documented using the measuring system. In addition to the jump height, the ground contact time is measured in milliseconds. The reactivity index (jump height/ground contact time) is determined from both parameters. The Lower Limb Symmetry Index (LSI) is determined in addition for a comparison between the sides. A qualitative assessment of the landing should be performed as well.

**Assessment and orientation values:**

An LSI ≥ 90 should be achieved in comparison between the sides. To avoid overlooking asymmetries due to a weaker uninjured side, the LSI should also not be greater than 110.

**Make sure the player does not push off the platform when jumping down. The arms remain firmly on the hips during the entire jump. The ankle, knee, and hip joint are extended when jumping and also in the airborne phase. Even during landing, pulling in the legs is not permitted.**

**The hop tests should be performed only using shoes with low damping, meaning indoor shoes, and on a hard surface. Running shoes are not suitable.**
Assessing the movement quality
The movement quality is assessed using the Single-Leg Landing Error Scoring System (SL-LESS). It assesses the movement quality in the sagittal and frontal planes based on the criteria in the assessment table. The total number of points is classified as follows:

<table>
<thead>
<tr>
<th>Points</th>
<th>Movement Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–2</td>
<td>Good movement quality</td>
</tr>
<tr>
<td>3</td>
<td>Moderate movement quality</td>
</tr>
<tr>
<td>≥ 4</td>
<td>Deficient movement quality</td>
</tr>
</tbody>
</table>

Generally the movement quality should also be determined for the uninjured side.

$IC = initial contact$

$MKF = maximum knee flexion$

$MKV = maximum knee valgus$

<table>
<thead>
<tr>
<th>Sagittal plane</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Item</strong></td>
</tr>
<tr>
<td>1. Forward Trunk Flexion at IC</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>2. Knee Flexion at IC</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>3. Ankle Plantarflexion at IC</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>4. Forward Trunk Flexion Displacement</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>5. Knee Flexion Displacement</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>6. Ankle Dorsiflexion Displacement</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
### Frontal plane

<table>
<thead>
<tr>
<th>Item</th>
<th>Error (1 point)</th>
<th>Good (0 points)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7. Knee Valgus at IC</td>
<td>At IC, a line drawn straight down from the center of the patella is medial to the midfoot</td>
<td>The line goes through the midfoot</td>
</tr>
<tr>
<td></td>
<td>1st attempt</td>
<td>1st attempt</td>
</tr>
<tr>
<td></td>
<td>2nd attempt</td>
<td>2nd attempt</td>
</tr>
<tr>
<td></td>
<td>3rd attempt</td>
<td>3rd attempt</td>
</tr>
<tr>
<td>8. Lateral Trunk Flexion at IC</td>
<td>At IC, the midline of the trunk is flexed to the left or the right side of the body</td>
<td>The trunk is not flexed to the left or right side of the body</td>
</tr>
<tr>
<td></td>
<td>1st attempt</td>
<td>1st attempt</td>
</tr>
<tr>
<td></td>
<td>2nd attempt</td>
<td>2nd attempt</td>
</tr>
<tr>
<td></td>
<td>3rd attempt</td>
<td>3rd attempt</td>
</tr>
<tr>
<td>9. Knee Valgus Displacement</td>
<td>At MKV a line drawn straight down from the center of the patella runs through the great toe or is medial to the great toe</td>
<td>The line is lateral to the great toe</td>
</tr>
<tr>
<td></td>
<td>1st attempt</td>
<td>1st attempt</td>
</tr>
<tr>
<td></td>
<td>2nd attempt</td>
<td>2nd attempt</td>
</tr>
<tr>
<td></td>
<td>3rd attempt</td>
<td>3rd attempt</td>
</tr>
<tr>
<td>10. Pelvic Drop</td>
<td>During landing the contralateral pelvis positioned lower than the ipsilateral pelvis</td>
<td>Both sides of the pelvis remain level</td>
</tr>
<tr>
<td></td>
<td>1st attempt</td>
<td>1st attempt</td>
</tr>
<tr>
<td></td>
<td>2nd attempt</td>
<td>2nd attempt</td>
</tr>
<tr>
<td></td>
<td>3rd attempt</td>
<td>3rd attempt</td>
</tr>
<tr>
<td>11. Tibial Rotation (toe pointed in/out)</td>
<td>Between IC and MKF the foot is internally/externally rotated more than 30°</td>
<td>If the foot is not internally/externally rotated more than 30°</td>
</tr>
<tr>
<td></td>
<td>1st attempt</td>
<td>1st attempt</td>
</tr>
<tr>
<td></td>
<td>2nd attempt</td>
<td>2nd attempt</td>
</tr>
<tr>
<td></td>
<td>3rd attempt</td>
<td>3rd attempt</td>
</tr>
</tbody>
</table>

**Points, 1st attempt (0–11)**

**Points, 2nd attempt (0–11)**

**Points, 3rd attempt (0–11)**

Table 2: SL-LESS Itemized Description (O’Connor 2015)
11.2 Figure of 8 Hop\textsuperscript{53}

The figure of 8 hop exhibits excellent reliability and helps identify athletes with an ankle instability. This is because athletes have to make lateral movements during the figure of 8 hop, which leads to high loads on the lateral ankle stabilizers.

**Objective:**
- Checking the lateral ankle stability

**Materials required:**
- 2 cones
- Measuring tape
- Time measuring system with light barrier

**Performing the test**

Shoes are worn for the test. Start with the affected leg. The test person stands behind the starting line on the affected leg. They have to jump on one leg in a figure eight around the cones (distance five meters) as quickly as possible, twice in succession. Then the test is repeated, jumping on the other leg. The test is carried out per side, once as a trial (80 percent of maximum performance) and two times as a measured test.

The best attempt is assessed. The test person gets a one-minute break between the attempts.

**Measurement:**
The time in seconds required to negotiate the course twice in succession is measured per side. The time is rounded to two decimal places and noted. The Lower Limb Symmetry Index (LSI) is determined in addition for a comparison between the sides.

**Assessment and orientation values:**
A cut-off value of 17.36 seconds has been established in the technical literature. That means test persons who take longer than 17.36 seconds are assessed as having postural instability.

An LSI ≥ 90 should be achieved in comparison between the sides. To avoid overlooking asymmetries due to a weaker uninjured side, the LSI should also not be greater than 110.

\textsuperscript{53} Docherty et al. 2005, Sharma et al. 2011, Linens et al. 2014, Wright et al. 2017
11.3 Side Hop

The side hop test is reliable and identifies athlete with postural instability. A positive correlation between ankle instability and deficits in the side-hop test has been shown in the technical literature. This is likely because athletes have to make lateral movements during the side hop, which leads to high loads on the lateral ankle stabilizers.

Objective:
• Checking the mediolateral ankle stability
• Assessing the movement quality

Materials required:
• Stopwatch
• Tape
• Video camera

Performing the test

Shoes are worn for the test. Start with the affected leg. The test person stands behind the starting line on the affected leg.

After receiving a start command, they jump from this position over both marking strips with the supporting leg (tape strips, spacing 30 centimeters). The test person is instructed to complete 10 jumps as quickly as possible (1 jump = 1 x over and back). If the tape is touched on landing, that jump is invalid and not counted. The test is invalid and has to be repeated if the contralateral foot is set down or the test person falls down.

Then the test is performed with the other leg. The test is carried out per side, once as a trial (80 percent of maximum performance) and two times as a measured test.

The best attempt is assessed. The test person gets a one-minute break between the attempts.

Measurement:
The time in seconds required to complete 10 jumps is measured per side (1 jump = 1 x over and back). The time is rounded to two decimal places and noted.

The Lower Limb Symmetry Index (LSI) is determined in addition for a comparison between the sides.

Assessment and orientation values:
A cut-off value of 12.88 seconds has been established in the technical literature. That means test persons who take longer than 12.88 seconds are assessed as having postural instability.

An LSI ≥ 90 should be achieved in comparison between the sides. To avoid overlooking asymmetries due to a weaker uninjured side, the LSI should also not be greater than 110.

When inertial sensors or a force measurement plate are used, the frequency and ground contact time in particular should be examined in comparison between the sides.

Figure 19: Side Hop

12  Agility

Why this test category?
Reacting quickly to a stimulus, starting and stopping repeatedly, and fast direction changes are permanent and performance determining elements of sports.

At the same time, these situations are often associated with a risk of injury so prevention is required.

What tests should be performed as a minimum?
• Modified T-test

In order to take cognitive factors, such as perception and decision-making within the framework of a test situation, into account in addition to checking the directional change or multi-directional speed, test systems with an external stimulus are currently considered the gold standard.

12.1  T-test\textsuperscript{55}

Sports are defined by short kicks, braking, and stopping movements, and fast direction changes when faking and feinting. The T-test represents the requirements for multi-directional speed through various movement patterns (running forward, sideways, and backward) and several direction changes.

Objective:
• Checking the multi-directional speed

Materials required:
• 4 cones
• Measuring tape
• Time measuring system with light barrier
• Test record

Performing the test

The test person sprints from the starting point (A) to the first cone (B), touches it with the right hand and runs sideways to the second cone (C), touching it with the left hand. Then they run sideways to the right to the third cone (D) and touch it with the right hand.

Subsequently they return sideways to the middle (B), touch the cone with the left hand and run backwards as fast as possible to the starting point (A). The test is carried out once as a trial (80 percent of maximum performance) and two times as a measured test. The best attempt is assessed.

Important:
The legs are not crossed while moving sideways, and the eyes have to look forward during the entire test.

\textsuperscript{55} Sassi et al. 2009
**Measurement:**
The total time per heat is noted.

**Assessment and orientation values:**

**Men:**
- Far above average: < 5.70 s
- Above average: 5.70–5.99 s
- Average: 6.00–6.39 s
- Below average: 6.40–6.70 s
- Far below average: > 6.70 s

**Women:**
- Far above average: < 6.70 s
- Above average: 6.70–6.99 s
- Average: 7.00–7.39 s
- Below average: 7.40–7.70 s
- Far below average: > 7.70 s
## 13 Summary of the evaluation criteria

The following assessment criteria should be met in full before a return to play recommendation is made. A comparison with the individual reference values from a pre-injury screening is recommended to assess the collected values. If these values are not available, cut-off values and/or orientation values from the technical literature are provided for each test.

<table>
<thead>
<tr>
<th>Test category</th>
<th>Test</th>
<th>Return to play criterion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical examination</td>
<td>Palpation</td>
<td>No pain, swelling has largely gone down, and no increase in swelling during or after load application</td>
</tr>
<tr>
<td></td>
<td>Passive ankle mobility</td>
<td>Unrestricted mobility</td>
</tr>
<tr>
<td></td>
<td>Active mobility – knee to wall test</td>
<td>≥ 10 cm</td>
</tr>
<tr>
<td></td>
<td>Skin surface temperature</td>
<td>Temperature difference ≤ 2 °C in comparison between the sides, increase after load application not &gt; 1 °C</td>
</tr>
<tr>
<td></td>
<td>Clinical tests (for example anterior drawer test, talar tilt test, squeeze test)</td>
<td>Negative</td>
</tr>
<tr>
<td></td>
<td>Control of peroneus muscles</td>
<td>Movement possible against slight resistance and with normal force</td>
</tr>
<tr>
<td>Self-reported outcome measures</td>
<td>Cumberland Ankle Instability Tool (CAIT)</td>
<td>CAIT value ≥ 28</td>
</tr>
<tr>
<td></td>
<td>Injury-Psychological Readiness to Return to Sport (I-PRRS Scale)</td>
<td>I-PRRS value ≥ 50</td>
</tr>
<tr>
<td></td>
<td>Foot and Ankle Disability Index Sport (FADI Sport)</td>
<td>FADI value ≥ 29 (90 %)</td>
</tr>
<tr>
<td>Postural control</td>
<td>Star Excursion Balance Test (SEBT)</td>
<td>Composite score ≥ 94 %</td>
</tr>
<tr>
<td></td>
<td>Reach distance differences in comparison between the sides ≤ 4 cm</td>
<td></td>
</tr>
<tr>
<td>Strength</td>
<td>Heel Rise Test</td>
<td>&gt; 30 repetitions</td>
</tr>
<tr>
<td></td>
<td>Single-Leg Squat</td>
<td>Assessment of movement quality as “good”</td>
</tr>
<tr>
<td>Hop tests</td>
<td>Single-Leg Drop Jump</td>
<td>LSI ≥ 90 and ≤ 110</td>
</tr>
<tr>
<td></td>
<td>SL-LESS ≤ 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Side Hop</td>
<td>LSI ≥ 90 and ≤ 110</td>
</tr>
<tr>
<td></td>
<td>Time ≤ 12.88 s</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Figure of 8 Hop</td>
<td>LSI ≥ 90 and ≤ 110</td>
</tr>
<tr>
<td></td>
<td>Time ≤ 17.36 s</td>
<td></td>
</tr>
<tr>
<td>Agility</td>
<td>T-test</td>
<td>&lt; 6.40 s for men and 7.40 s for women</td>
</tr>
</tbody>
</table>
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