Clinical assessment of acute lateral ankle sprain injuries (ROAST): 2019 consensus statement and recommendations of the International Ankle Consortium

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Complete List of Authors: Delahunt, Eamonn; University College Dublin, School of Public Health, Physiotherapy and Population Science
Bleakley, Chris; High Point University
Bossard, Daniela; University College Dublin
Caulfield, Brian; University College Dublin, School of Physiotherapy
Docherty, Carrie
Doherty, Cailbhe; University College Dublin
Fourchet, François; Hôpital de la Tour, Swiss Olympic Medical Center
Fong, Daniel; Loughborough University, School of Sport, Exercise and Health Sciences
Hertel, Jay; University of Virginia, Kinesiology
Hiller, Claire; University of Sydney, Faculty of Health Sciences
Kaminski, Thomas; University of Delaware, Depr of Health, Nutrition and Exercise Sciences
McKeon, Patrick; University of Kentucky, Rehabilitation Sciences
Refshauge, Kathryn; University of Sydney, Health Sciences
Remus, Alexandria; University College Dublin
Verhagen, Evert; EMGO Institute for Health and Care Research, Public and Occupational Health
Vicenzino, Bill (Guglielmo); University of Queensland, Physiotherapy
Wikstrom, Erik; University of North Carolina at Chapel Hill,
Gribble, Phillip; University of Kentucky, Department of Rehabilitation Science

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Title: Clinical assessment of acute lateral ankle sprain injuries: consensus statement and recommendations of the International Ankle Consortium


Affiliations: 
1. School of Public Health, Physiotherapy & Sports Science, University College Dublin, Dublin, Ireland 
2. Institute for Sport & Health, University College Dublin, Dublin, Ireland 
3. Department of Physical Therapy, High Point University, North Carolina, USA 
4. Insight Centre for Data Analytics, University College Dublin, Dublin, Ireland 
5. School of Public Health, Indiana University, Bloomington, Indiana, USA 
6. Motion Analysis Laboratory, Hôpital De La Tour, Meyrin, Geneva, Switzerland 
7. National Centre for Sport & Exercise Medicine, School of Sport, Exercise & Health Sciences, Loughborough University, Loughborough, Leicestershire, UK 
8. Department of Kinesiology, Curry School of Education, University of Virginia, Virginia, USA 
9. School of Physiotherapy, Faculty of Health Sciences, University of Sydney, Sydney, Australia 
10. Department of Kinesiology & Applied Physiology, University of Delaware, Newark, Delaware, USA 
11. Department of Exercise & Sport Sciences, School of Health Sciences & Human Performance, Ithaca College, Ithaca, New York, USA 
12. Amsterdam Collaboration on Health and Safety in Sports & Department of Public & Occupational Health, Amsterdam Movement Science, VU University Medical Center, Amsterdam, the Netherlands 
13. School of Health and Rehabilitation Sciences, University of Queensland, Queensland, Australia 
14. Department of Exercise & Sport Science, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina, USA 
15. Division of Athletic Training, College of Health Sciences, University of Kentucky, Lexington, Kentucky, USA

Corresponding Author: Eamonn Delahunt 
School of Public Health, Physiotherapy & Sports Science 
University College Dublin 
Health Science Centre 
Belfield 
Dublin 4 
Ireland 
E-Mail address: eamonn.delahunt@ucd.ie
ABSTRACT

Lateral ankle sprain injury is the most common musculoskeletal injury incurred by individuals who participate in sports and recreational physical activities. Following initial injury a high proportion of individuals develop long-term injury-associated symptoms and chronic ankle instability. The development of chronic ankle instability is consequent upon the interaction of mechanical and sensorimotor insufficiencies/impairments that manifest following acute lateral ankle sprain injury. To reduce the propensity for developing chronic ankle instability, clinical assessments should evaluate whether patients in the acute phase following lateral ankle sprain injury exhibit any mechanical and/or sensorimotor impairments.

This modified Delphi study was undertaken under the auspices of the executive committee of the International Ankle Consortium. The primary aim was to develop recommendations, based on expert (n = 14) consensus, for structured clinical assessment of acute lateral ankle sprain injuries. After two modified Delphi rounds, consensus was achieved on the clinical assessment of acute lateral ankle sprain injuries. Consensus was reached on a minimum standard clinical diagnostic assessment. Key components of this clinical diagnostic assessment include; establishing the mechanism of injury, as well as the assessment of ankle joint bones and ligaments. Through consensus, the expert panel also developed the International Ankle Consortium Rehabilitation-Oriented ASSessment (ROAST). The International Ankle Consortium ROAST will help clinicians identify mechanical and/or sensorimotor impairments that are associated with chronic ankle instability.
This consensus statement from the International Ankle Consortium aims to be a key resource for clinicians who regularly assess individuals with acute lateral ankle sprain injuries.
INTRODUCTION

Lateral ankle sprains are the most common lower limb musculoskeletal injury incurred by individuals who participate in sports and recreational physical activities.\textsuperscript{1,2} The prevalence of lateral ankle sprains amongst the general population is also substantial, as demonstrated by hospital Emergency Department data.\textsuperscript{3-6} Up to 70% of the general population report having incurred an ankle injury during their lifetime.\textsuperscript{7}

Lateral ankle sprain injuries associate with high societal economic costs, related to injury diagnosis, initial management, rehabilitation, and reduced work productivity. In the UK, Cooke et al\textsuperscript{6} reported an average of 6.9 days of paid work lost due to lateral ankle sprain injuries, adding at least an additional £805 in lost productivity costs for each injury to the overall costs, compared with £135 of direct healthcare costs. The combination of high incidence and both direct and indirect costs makes the economic burden of lateral ankle sprain injuries indisputable.

Lateral ankle sprain injuries have the highest reinjury rate of all lower limb musculoskeletal injuries.\textsuperscript{8} Individuals who incur an acute lateral ankle sprain injury have a twofold increased risk of reinjury in the year following their initial injury.\textsuperscript{9} Reinjury coincides with the progression of a number of chronic injury-associated sequelae including: pain, persistent swelling, feelings of ankle joint instability, ankle joint “giving-way”, recurrent injury and reduced functional capacity as illustrated by reduced scores on patient reported outcome measures questionnaires.\textsuperscript{1,2,10-12} These injury-associated sequelae constitute
the characteristic features of chronic ankle instability.\textsuperscript{10-13} High reinjury rates might be due to inadequate rehabilitation,\textsuperscript{1,2} and/or premature return to sport.\textsuperscript{14} Hence, reducing the risk of reinjury and the propensity for the development of chronic ankle instability is a key priority after acute lateral ankle sprain injury occurrence.\textsuperscript{15}

The interaction of mechanical and sensorimotor impairments that develop following acute lateral ankle sprain injury contribute to the development of chronic ankle instability.\textsuperscript{16} Therefore, clinical assessments should evaluate whether a patient in the acute phase following lateral ankle sprain injury exhibits any mechanical and/or sensorimotor impairments. However, previous research has documented that clinicians may have a limited understanding of the full spectrum of mechanical and sensorimotor impairments that manifest following an acute lateral ankle sprain injury.\textsuperscript{17} Hence, the treatment being administered following acute lateral ankle sprain injury is unlikely to be based on objectively identified mechanical and sensorimotor impairments. As such, it is necessary to develop recommendations for structured clinical assessment following acute lateral ankle sprain injury, which addresses both mechanical and sensorimotor impairments. Considering this, the aim of this project was to develop, based on expert consensus, recommendations for structured clinical assessment of acute lateral ankle sprain injuries. These recommendations should have a particular emphasis on impairments that are known to associate with chronic ankle instability.
MATERIALS AND METHODS

Study Design

This modified (consisting of 2 rounds) Delphi study was undertaken under the auspices of the executive committee of the International Ankle Consortium. The International Ankle Consortium, which was inaugurated in 2004, is an international community of researchers and clinicians whose primary academic purpose is to promote scholarship and dissemination of research-informed knowledge related to ankle sprain injury and chronic ankle instability. A previous consensus statement of the International Ankle Consortium\(^2\) and its supporting evidence document\(^1\) were utilized as the starting point for this modified Delphi study. The protocol for the present modified Delphi study, which details the study methodology, has been published.\(^{18}\) In summary, our modified Delphi process started with an anonymous online questionnaire (round 1) specifically related to the clinical assessment of acute lateral ankle sprain injuries. The online questionnaire consisted of a number of distinct sections including: (1) participant demographics; (2) subjective assessment and patient reported outcome measures; (3) diagnostic imaging; (4) objective assessment (including assessment of bony integrity, ligamentous integrity, range of motion, arthrokinematics, strength, neurodynamics, postural balance); (5) performance assessment. An email was sent to all members of the executive committee of the International Ankle Consortium requesting their participation in the online questionnaire. Participants were required to complete the online questionnaire within 4 weeks of receiving the invitation email. A reminder email was sent to all participants two weeks after the initial invitation email. Regarding the online questionnaire, participants were
requested to respond to questions related to the importance of different constructs of the clinical assessment of acute lateral ankle sprain injuries on a scale of 1 to 5 (1 = strongly disagree; 2 = disagree; 3 = no opinion; 4 = agree; 5 = strongly agree). They also had the opportunity to elaborate further on how they would assess certain structures or functions by providing expanded answers to open-ended questions. The responses to the online questionnaire were collated, analysed (completed August 2017) and used as the foundation for a subsequent consensus meeting of the executive committee of the International Ankle Consortium (i.e. international multi-disciplinary expert group). This consensus meeting (held on 14th September 2017) represented round 2 of this modified Delphi method.

Data Analysis

Data from round 1 were automatically extracted from the online questionnaire to a Google Sheets document. For questions with a Likert scale response, frequency tables were automatically generated and the level of agreement was calculated for each response. To establish the level of agreement, the total percentage of “Strongly Agree” (5 on the Likert Scale) and “Agree” (4 on the Likert Scale) responses was calculated. Consensus agreement was defined as ≥ 75%, partial agreement was defined as 50% – 75% agreement, whilst no agreement was defined as < 50%. Qualitative data (i.e., open-ended responses to questions as part of the online questionnaire) and responses that reached partial agreement were used as discussion points in round 2 of the modified Delphi process.
RESULTS

After two consecutive modified Delphi rounds, performed between May 2017 and September 2017, full consensus was achieved on the clinical assessment of acute lateral ankle sprain injuries (Figure 1 and Table 2).

Expert Panel

Fourteen experts from the executive committee of the International Ankle Consortium were invited to participate, all of who agreed. The expert panel (males = 84.6%, females = 15.4%; age = 45 ± 6.2 years) were employed in a number of countries including Australia, Ireland, Netherlands, Switzerland, USA and the UK. All expert panel members had authored or co-authored numerous peer-reviewed articles on the topics of lateral ankle sprain and chronic ankle instability, as well as having contributed to previous consensus statements. The years of clinical experience varied (15.7 ± 13.5 years) across the members. The expert panel members assessed an average of 40 patients a year with lateral ankle sprain injuries and/or chronic ankle instability. The expert panel members identified their expertise in the clinical assessment of patients with acute lateral ankle sprain injuries and/or chronic ankle instability as an average of 8 out of 10, with 10 being the highest level of expertise.

Delphi Round 1

All experts (100%) participated in round 1, however answers for one participant were excluded due to technical issues. Thirteen participants successfully completed round 1. Expert consensus (≥ 75% agreement) was reached on 37 of the 62 questions included in the online questionnaire.
Fifteen criteria reached partial agreement (50% – 75%) and hence were brought forward for discussion in round 2. Table 1 (supplementary file) details the level of agreement for each of the questions in the online questionnaire.

**Delphi Round 2**

Ten of the 14 expert panel members were able to attend the executive committee meeting of the International Ankle Consortium, which functioned as Round 2 of the modified Delphi process. This meeting took place the day before the 7th International Ankle Symposium (14th of September 2017). Results from round 1, which reached ≥ 75% agreement, were automatically included in this consensus. Results from round 1 that reached partial agreement (50% – 75%) along with responses to open-ended questions (part of the online questionnaire) were discussed further amongst the 10 experts who were present at round 2. To establish the level of agreement in Round 2, the total percentage of “Strongly Agree” (5 on the Likert Scale) and “Agree” (4 on the Likert Scale) responses was calculated. Consensus agreement was defined as ≥ 75%. Final consensus was reached in round 2 and is presented in Figures 1 and Table 2.

**Discussion**

This modified Delphi study involving experts from the executive committee of the International Ankle Consortium reached consensus on recommendations for clinical assessment of acute lateral ankle sprain injuries. With regard to injury diagnosis there were 5 important considerations, which the expert panel reached consensus upon. These are as follows: [1] mechanism of injury; [2]

Regarding the evaluation of mechanical and sensorimotor impairments, there were 10 important considerations, which the expert panel reached consensus upon. These are as follows: [1] pain; [2] swelling; [3] range of motion; [4] arthrokinematics; [5] muscle strength; [6] static postural balance; [7] dynamic postural balance; [8] gait; [9] physical activity level; [10] patient reported outcome measures. Hence, the experts agreed that these should be clustered and termed the International Ankle Consortium Rehabilitation-Oriented Assessment (ROAST). We advocate that clinicians should consult these recommendations as they detail an imperative first step towards the development of an appropriate management pathway for this prevalent injury.

Clinical Diagnostic Assessment

The expert panel agreed upon a pragmatic minimum standard clinical diagnostic assessment, which does not require specialist equipment (e.g. diagnostic imaging) and can be applied across a range of clinical settings.

Mechanism of Injury

Establishing the mechanism of injury is advocated as it can give clinicians an indication of what anatomical structures are likely to have incurred insult and hence, what tissues should be prioritised during clinical assessment.
Numerous published articles have described the kinematics of lateral ankle sprain injury occurrences. Clinicians should suspect injury to the lateral ligaments of the ankle joint if the patient reports that the mechanism of injury involved a sudden rapid inversion and internal rotation loading of the foot and ankle complex, irrespective of sagittal plane angular displacement. The mechanisms of injury associated with ankle syndesmosis ligament injuries are less clear, but have been reported to include external rotation of the foot, eversion of the talus within the ankle mortise and excessive dorsiflexion. Therefore, clinicians should suspect injury to the syndesmosis ligaments if the patient describes/recalls any of the aforementioned injury mechanisms (i.e. external rotation of the foot, hyper-dorsiflexion).

**History of Previous Lateral Ankle Sprain**

Establishing history of previous lateral ankle sprain injury or ankle joint injury is endorsed primarily for two reasons. Firstly, it has been established that previous lateral ankle sprain injury heightens the risk of injury recurrence. Secondly, if the presenting patient has previously sustained a lateral ankle sprain injury, it is probable that injury-associated mechanical and sensorimotor impairments are present, which should be addressed as part of a comprehensive rehabilitation programme.

**Weight-bearing Status**

Weight-bearing status should be established, both via subjective reporting related to the time of injury, and during clinical presentation in accordance with the Ottawa Ankle Rules. An inability to weight-bear four steps
immediately after injury and upon clinical presentation should alert clinicians
to the possibility of ankle joint fracture.\textsuperscript{28} The likelihood of ankle joint fracture
can be established with high sensitivity by utilizing the Ottawa Ankle Rules,
whereby, weight-bearing status and clinical assessment of the “malleolar
zone” are combined in a clinical prediction rule.\textsuperscript{28}

\textbf{Clinical Assessment of Bones}

The Ottawa Ankle Rules\textsuperscript{28} should be utilised to determine the likelihood of
ankle joint fracture. If a patient reports pain in the “malleolar zone” and if this
is accompanied by pain on palpation of the distal 6 cm of the posterior edge of
the medial malleolus, or pain on palpation of the distal 6 cm of the posterior
dge of the lateral malleolus, or an inability to weight-bear four steps
immediately after injury and upon clinical presentation, then an ankle joint X-
ray is warranted (appendix I). The Ottawa Ankle Rules have been reported to
have higher sensitivity than specificity, meaning that they are better at ruling
out the possibility of ankle joint fracture, rather than making a diagnosis of
ankle joint fracture.\textsuperscript{29} Following an inversion and internal rotation injury of the
ankle joint the pre-test probability of ankle joint fracture is less than 15\%.\textsuperscript{30} If
the Ottawa Ankle Rules are implemented in such instances but findings are
negative (i.e. none of the rules are positive; negative likelihood ratio = 0.02),
the post-test probability of ankle joint fracture is less than 1\%.

\textbf{Clinical Assessment of Ligaments}

The clinical assessment of the integrity of the lateral ligaments of the ankle
joint, as well as the ankle joint syndesmosis ligaments is advocated. The main
lateral ligamentous stabilizers of the ankle joint are: the anterior talofibular ligament, the calcaneofibular ligament and the posterior talofibular ligament. The anterior talofibular ligament is the most commonly injured of these ligaments. It originates at the anterior margin of the lateral malleolus and it runs anteromedially to insert on the talar body immediately anterior to the joint surface occupied by the lateral malleolus. Replication of the patient’s “known pain” upon palpation and/or stressing (i.e. passive plantar flexion and inversion) of the anterior talofibular ligament is indicative of injury to this ligament (appendix I). Clinical stability tests to assess for complete disruption of the anterior talofibular ligament are best performed between 4 and 6 days after injury. The anterior drawer test is the most sensitive clinical stability test to assess for complete rupture of the anterior talofibular ligament. The sensitivity and specificity of this test are 0.96 and 0.84 respectively, with an associated negative likelihood ratio of 0.04. This means that if there is no “sulcus sign” upon testing the integrity of the anterior talofibular ligament using the anterior drawer test then there is low probability that it is completely disrupted/ruptured (appendix I).

The calcaneofibular ligament originates from the anterior part of the lateral malleolus and courses obliquely downwards and backwards to attach to the posterior region of the lateral calcaneal surface. It is superficially crossed by the peroneal tendons and sheaths, with only approximately 1 cm of the ligament being uncovered and directly palpable. Replication of the patient’s “known pain” upon palpation and/or stressing (i.e. passive dorsiflexion of the ankle joint combined with passive inversion of the rearfoot) of the calcaneofibular ligament is indicative of injury to this ligament (appendix I).
The prevalence of ankle joint syndesmosis ligament injury (with or without concomitant lateral ligament involvement) has been reported to be 20%. As such, it is important to undertake a clinical assessment of the ankle joint syndesmosis ligaments. Sman and colleagues have reported that localized tenderness upon palpation of the syndesmosis ligaments is the most sensitive clinical assessment test (sensitivity = 0.92), whilst the squeeze test is the most specific clinical assessment test (specificity = 0.88). Thus, if the most sensitive clinical assessment test (palpation of the syndesmosis ligaments) and the most specific clinical assessment test (squeeze test) are positive, there is a high probability of injury to the syndesmosis ligaments (appendix I).

**International Ankle Consortium Rehabilitation-Oriented AS sessmenT (ROAST)**

The expert panel agreed upon a rehabilitation-oriented assessment, with the primary purpose of identifying the presence of mechanical and/or sensorimotor impairments that are known to contribute to the development of chronic ankle instability. To determine the true presence of these impairments in the acute phase following injury clinicians can utilize the non-injured side as a comparator.

**Pain**

Quantification of a patient’s current self-reported ankle joint pain is endorsed. Self-reported pain should be used as a clinically oriented outcome measure to guide the progression of exercise-based rehabilitation and to assess the efficacy of treatments implemented. Numerous options exist for assessing
ankle joint pain in clinical settings. The numeric rating scale for pain is a valid and reliable scale to measure pain intensity. It can be administered both verbally and in writing and can be used to quantify pain during various activities. However, it only evaluates one component of the pain experience, namely, pain intensity. The assessment of ankle-specific pain is a central component of the Foot and Ankle Disability Index (appendix I), which is a patient reported outcome questionnaire designed to assess functional limitations related to foot and ankle conditions.

**Swelling**

The assessment of ankle joint swelling is advocated. Ankle joint swelling may alter somatosensory input to the central nervous system, which, through the process of arthrogenic muscle inhibition could negatively affect functional joint stability. The quantification of ankle joint swelling should be used as a clinically oriented outcome measure to direct exercise-based rehabilitation progression and to measure the efficacy of therapeutic interventions. The figure-of-eight method has been reported to be a valid and reliable clinically applicable method for indirectly quantifying ankle joint swelling (appendix I).

**Range of Motion**

A comprehensive assessment of both passive and active ankle joint range of motion is endorsed. The quantification of ankle joint range of motion should be used as a clinically oriented outcome measure to guide exercise-based rehabilitation progression and to gauge the efficacy of therapeutic
interventions. Of particular concern following lateral ankle sprain injury is the propensity for the development of a restriction in ankle joint dorsiflexion range of motion. Sufficient ankle joint dorsiflexion range of motion is important as it has been reported to explain up to 28% of the variance in dynamic postural stability performance, as assessed via the anterior reach direction of the Star Excursion Balance Test. The weight-bearing lunge test is a clinically applicable, valid and reliable method for assessing ankle joint dorsiflexion range of motion (appendix I).

**Arthrokinematics**

Assessment of talocrural joint arthrokinematics is advocated. It has been proposed that impairments in ankle joint dorsiflexion range of motion are likely related to a disruption in talocrural arthrokinematics. This is supported by studies that have reported either restrictions in posterior talar glide, or the existence of an anterior positional fault of the talus within the talocrural joint. The posterior talar glide test as reported by Denegar et al can be used to assess posterior glide of the talus within the talocrural joint.

**Muscle Strength**

Assessment of ankle joint muscle strength is advocated. During the contractile process, musculotendinous units generate stiffness, resulting in dynamic protection of joints. A strength deficit of the ankle musculature could compromise the integrity of the ankle joint to withstand sudden injurious movements. Individuals with chronic ankle instability have been reported to exhibit deficits in ankle joint strength. Muscle strength can be measured
objectively using isokinetic dynamometers and hand-held dynamometers. A hand-held dynamometer offers a practical clinically applicable alternative to isokinetic dynamometry due to its portability, reduced cost and convenient size.\textsuperscript{52} Ankle joint strength can be measured in an objective and reliable manner using hand-held dynamometry (appendix I).\textsuperscript{53} Additionally, there is evidence to suggest that hip strength may be an important factor to also consider, as research has identified proximal strength deficits in individuals with chronic ankle instability.\textsuperscript{54}

\textbf{Static Postural Balance}

Assessing static postural balance is endorsed as an integral component of a rehabilitation-oriented clinical assessment following lateral ankle sprain injury. Deficiencies in static postural stability have been consistently identified in individuals with chronic ankle instability.\textsuperscript{55} Both the Balance Error Scoring System,\textsuperscript{56} and the Foot Lift Test,\textsuperscript{57} are clinically applicable methods for assessing static postural balance (appendix I).

\textbf{Dynamic Postural Balance}

Assessing dynamic postural balance is endorsed as a central component of a rehabilitation-oriented clinical assessment following lateral ankle sprain injury. Impairments in dynamic postural balance performance have been steadfastly identified in individuals with chronic ankle instability.\textsuperscript{55,58} The Star Excursion Balance Test can be readily used in the clinic to assess dynamic postural balance performance (appendix I).\textsuperscript{58}
Gait

Assessment of walking gait is endorsed following acute lateral ankle sprain injury. It has been posited that the high potential for lateral ankle sprain injury recurrence during gait is likely due to inappropriate positioning of the lower extremity joints in the loading-unloading transitions between stance and swing.\textsuperscript{59,60} Aberrancies in lower extremity biomechanics during walking gait have been consistently identified in individuals with chronic ankle instability.\textsuperscript{61,62}

Physical Activity Level

Establishing the patient’s level of physical activity prior to incurring their lateral ankle sprain injury is endorsed primarily for two reasons. Firstly, it can help guide the specificity of exercise-based rehabilitation. Secondly, it can be used to establish whether the patient has returned to his/her pre-injury participation level. An example of an appropriate questionnaire is the Tegner activity-level scale (appendix I).\textsuperscript{63}

Patient Reported Outcome Measures

Patient reported outcome measures improve the quality of assessing and reporting the outcome of treatments and their use as part of a rehabilitation-oriented clinical assessment following lateral ankle sprain injury is advocated. A number of patient reported outcome measures exist which have been commonly used with individuals with chronic ankle instability.\textsuperscript{64} Examples of appropriate patient reported outcome measures to assess function of the

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ankle include the Foot and Ankle Disability Index, and the Foot and Ankle Ability Measure (appendix I).

Future research
High-quality prospective research is needed to determine whether these recommendations for clinical assessment of acute lateral ankle sprain injuries can optimize the management of individuals who have incurred this injury.

CONCLUSION
The executive committee of the International Ankle Consortium reached consensus on recommendations for structured clinical assessment of acute lateral ankle sprain injuries. Recommendations are provided on an initial diagnostic clinical assessment. The International Ankle Consortium ROAST is also presented, which places emphasis on the assessment of mechanical and sensorimotor impairments that are known to associate with chronic ankle instability.

Contributions: All authors have made substantial contributions to this manuscript. They have all participated in the concept and design, analysis and interpretation of data, and drafting and revising the manuscript. All authors have read the manuscript and agreed to submission for publication.

Competing Interests: None declared.

Provenance and peer review: Not commissioned; peer reviewed.
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Table 2. International Ankle Consortium Rehabilitation-Oriented ASsessmenT (ROAST)

<table>
<thead>
<tr>
<th>What clinicians should assess following acute lateral ankle sprain injury</th>
<th>Why?</th>
<th>How?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ankle joint pain</td>
<td>Guide progression of exercise-based rehabilitation. Assess the efficacy of treatments implemented.</td>
<td>Numeric rating scale for pain(^{36}) FADI(^{36})</td>
</tr>
<tr>
<td>Ankle joint swelling</td>
<td>Swelling can cause arthrogenic muscle inhibition. Guide progression of exercise-based rehabilitation. Evaluate the efficacy of treatments implemented.</td>
<td>Figure-of-eight(^{36,41})</td>
</tr>
<tr>
<td>Ankle joint range of motion</td>
<td>High propensity for the development of a dorsiflexion deficit. Impairments in ankle joint range of motion are consistently identified in individuals with CAI.</td>
<td>Weight-bearing lunge test(^{44-46})</td>
</tr>
<tr>
<td>Ankle joint arthrokinematics</td>
<td>Disruption in ankle joint arthrokinematics can result in a dorsiflexion deficit. Impairments in ankle joint arthrokinematics are regularly identified in individuals with CAI.</td>
<td>Posterior talus glide test(^{45})</td>
</tr>
<tr>
<td>Ankle joint muscle strength</td>
<td>Impairments in ankle joint strength compromise the functional integrity of the ankle joint. Impairments in ankle joint strength are regularly identified in individuals with CAI.</td>
<td>Hand-held dynamometry(^{53})</td>
</tr>
<tr>
<td>Static postural balance</td>
<td>Impairments in static postural balance are consistently identified in individuals with CAI.</td>
<td>BESS(^{56}) FLT(^{57})</td>
</tr>
<tr>
<td>Dynamic postural balance</td>
<td>Impairments in dynamic postural balance are consistently identified in individuals with CAI.</td>
<td>SEBT(^{58})</td>
</tr>
<tr>
<td>Gait</td>
<td>Impairments in gait are consistently identified in individuals with CAI.</td>
<td>Visual assessment for antalgic gait</td>
</tr>
<tr>
<td>Physical activity level</td>
<td>Guide the specificity of exercise-based rehabilitation.</td>
<td>Tegner activity-level scale(^{62})</td>
</tr>
<tr>
<td>Ankle joint specific patient reported outcome measures</td>
<td>Evaluate the efficacy of treatments implemented.</td>
<td>FADI(^{36}) FAAM(^{65})</td>
</tr>
</tbody>
</table>

FADI = Foot and Ankle Disability Index; CAI = chronic ankle instability; BESS = Balance Error Scoring System; FLT = Foot Lift Test; SEBT = Star Excursion Balance Test; FAAM = Foot and Ankle Ability Measure
Reviewer: 1

Comments to the Author

Thank you for implementing the feedback I have given you. Your manuscript has shown major improvement and clarification where some things were unclear to me before. The suggestions you have not implemented were well argumented and clear why you chose not to do so. I only have two final suggestions you may be able to use if appropriate.
RESPONSE: Thanks kindly

The only suggestions I still have are
1. For the method section: in your response you explain why your study is a modified Delphi method. I suggest implementing in the text explanation in terms of "(consisting of 2 rounds)"
RESPONSE: Modified as follows:
This modified (consisting of 2 rounds) Delphi study was undertaken under the auspices of the executive committee of the International Ankle Consortium.

2. Concerning data analysis, thank you for your explanation but I think this manuscript also has to be readable by itself. You refer in your comment to two other manuscripts. Please refer to them in your methods as well in case readers find these articles online and do not read the full published issue. Additionally please add a line explaining that the members who participated in this consensus meeting were ‘members of the executive committee of the international ankle consortium’ explaining why 14 were invited to participate.
Response: Modified as follows:
The protocol for the present modified Delphi study, which details the study methodology, has been published.¹⁸ In summary, our modified Delphi process started with an anonymous online questionnaire (round 1) specifically related to the clinical assessment of acute lateral ankle sprain injuries. The online questionnaire consisted of a number of distinct sections including: (1) participant demographics; (2) subjective assessment and patient reported outcome measures; (3) diagnostic imaging; (4) objective assessment (including assessment of bony integrity, ligamentous integrity, range of motion, arthrokinematics, strength, neurodynamics, postural balance); (5) performance assessment. An email was sent to all members of the executive committee of the International Ankle Consortium requesting their participation in the online questionnaire. Participants were required to complete the online questionnaire within 4 weeks of receiving the invitation email. A reminder email was sent to all participants two weeks after the initial invitation email. Regarding the online questionnaire, participants were requested to respond to questions related to the importance of different constructs of the clinical assessment of acute lateral ankle sprain injuries on a scale of 1 to 5 (1 = strongly disagree; 2 = disagree; 3 = no opinion; 4 = agree; 5 = strongly agree). They also had the opportunity to elaborate further on how they would assess certain structures or functions by providing expanded answers to open-ended questions. The responses to the online questionnaire were collated, analysed (completed August 2017) and used as the foundation for a subsequent consensus meeting of the executive committee of the International Ankle Consortium (i.e. international multi-disciplinary
expert group). This consensus meeting (held on 14th September 2017) represented round 2 of this modified Delphi method.
Title: Clinical assessment of acute lateral ankle sprain injuries: consensus statement and recommendations of the International Ankle Consortium

Authors:

Affiliations:
1 School of Public Health, Physiotherapy & Sports Science, University College Dublin, Dublin, Ireland
2 Institute for Sport & Health, University College Dublin, Dublin, Ireland
3 Department of Physical Therapy, High Point University, North Carolina, USA
4 Insight Centre for Data Analytics, University College Dublin, Dublin, Ireland
5 School of Public Health, Indiana University, Bloomington, Indiana, USA
6 Motion Analysis Laboratory, Hôpital De La Tour, Meyrin, Geneva, Switzerland
7 National Centre for Sport & Exercise Medicine, School of Sport, Exercise & Health Sciences, Loughborough University, Loughborough, Leicestershire, UK
8 Department of Kinesiology, Curry School of Education, University of Virginia, Virginia, USA
9 School of Physiotherapy, Faculty of Health Sciences, University of Sydney, Sydney, Australia
10 Department of Kinesiology & Applied Physiology, University of Delaware, Newark, Delaware, USA
11 Department of Exercise & Sport Sciences, School of Health Sciences & Human Performance, Ithaca College, Ithaca, New York, USA
12 Amsterdam Collaboration on Health and Safety in Sports & Department of Public & Occupational Health, Amsterdam Movement Science, VU University Medical Center, Amsterdam, the Netherlands
13 School of Health and Rehabilitation Sciences, University of Queensland, Queensland, Australia
14 Department of Exercise & Sport Science, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina, USA
15 Division of Athletic Training, College of Health Sciences, University of Kentucky, Lexington, Kentucky, USA

Corresponding Author:
Eamonn Delahunt
School of Public Health, Physiotherapy & Sports Science
University College Dublin
Health Science Centre
Belfield
Dublin 4
Ireland
E-Mail address: eamonn.delahunt@ucd.ie
ABSTRACT

Lateral ankle sprain injury is the most commonly incurred musculoskeletal injury by individuals who participate in sports and recreational physical activities. Following initial injury a high proportion of individuals develop long-term injury-associated symptoms and chronic ankle instability. The development of chronic ankle instability is consequent upon the interaction of mechanical and sensorimotor insufficiencies/impairments that manifest following acute lateral ankle sprain injury. To reduce the propensity for the development of chronic ankle instability, clinical assessments should evaluate whether patients in the acute phase following lateral ankle sprain injury exhibit any mechanical and/or sensorimotor impairments.

This modified Delphi study was undertaken under the auspices of the executive committee of the International Ankle Consortium. The primary aim was to develop recommendations, based on expert (n = 14) consensus, a guideline for structured clinical assessment of acute lateral ankle sprain injuries.

After two modified Delphi rounds, with contributions from 14 experts, consensus was achieved on the clinical assessment of acute lateral ankle sprain injuries. The expert panel reached consensus on a pragmatic minimum standard clinical diagnostic assessment. Key components of this clinical diagnostic assessment include: establishing the mechanism of injury, as well as the assessment of ankle joint bones and ligaments. Through consensus, the expert panel also developed the International Ankle Consortium Rehabilitation-Oriented Assessment (ROAST). The International Ankle Consortium ROAST will help clinicians identify mechanical and/or...
sensorimotor impairments that are known to be associated with chronic ankle instability.

This consensus statement from the International Ankle Consortium aims to be a key resource for clinicians who regularly assess individuals with who have incurred an acute lateral ankle sprain injuries.
INTRODUCTION

Lateral ankle sprains are the most commonly incurred lower limb musculoskeletal injury incurred by individuals who participate in sports and recreational physical activities.\(^1\,^2\) The prevalence of lateral ankle sprains amongst the general population is also substantial, as demonstrated by hospital Emergency Department data.\(^3\,^6\) Up to 70% of the general population report having incurred an ankle injury during their lifetime.\(^7\)

Lateral ankle sprain injuries associate with high societal economic costs, related to injury diagnosis, initial management, rehabilitation, and reduced work productivity. In the UK, Cooke et al\(^6\) reported an average of 6.9 days of paid work lost due to lateral ankle sprain injuries, adding at least an additional £805 in lost productivity costs for each injury to the overall costs, compared with £135 of direct healthcare costs. The combination of high incidence and both direct and indirect costs makes the economic burden of lateral ankle sprain injuries indisputable.

Lateral ankle sprain injuries have the highest reinjury/recurrence rate of all lower limb musculoskeletal injuries.\(^8\) Individuals who incur an acute lateral ankle sprain injury have a twofold increased risk of reinjury in the year following their initial injury occurrence.\(^9\) Reinjury coincides with the progression of a number of chronic injury-associated sequelae including pain, persistent swelling, feelings of ankle joint instability, ankle joint “giving-way”,

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recurrent injury and reduced functional capacity as illustrated by reduced scores on patient reported outcome measures questionnaires.\textsuperscript{1,2,10-12} These injury-associated sequelae constitute the characteristic features of chronic ankle instability.\textsuperscript{10-13} High reinjury rates might be due to inadequate rehabilitation,\textsuperscript{1,2} and/or premature return to sport.\textsuperscript{14} Hence, reducing the risk of reinjury and the propensity for the development of chronic ankle instability is a key priority after acute lateral ankle sprain injury occurrence.\textsuperscript{15}

The interaction of mechanical and sensorimotor impairments that develop following acute lateral ankle sprain injury contribute to the development of chronic ankle instability.\textsuperscript{16} Therefore, clinical assessments should evaluate whether a patient in the acute phase following lateral ankle sprain injury exhibits any mechanical and/or sensorimotor impairments. However, previous research has documented that clinicians may have a limited understanding of the full spectrum of mechanical and sensorimotor impairments that manifest following an acute lateral ankle sprain injury.\textsuperscript{17} Hence, the treatment being administered following acute lateral ankle sprain injury is unlikely to be based on objectively identified mechanical and sensorimotor impairments. As such, it is necessary to develop recommendations a guideline for structured clinical assessment following acute lateral ankle sprain injury, which addresses both mechanical and sensorimotor impairments. Considering this, the aim of this project was to develop, based on expert consensus, recommendations a guideline for structured clinical assessment of acute lateral ankle sprain injuries. These recommendations should have, with a particular emphasis on impairments that are known to associate with chronic ankle instability.
MATERIALS AND METHODS

Study Design

This modified (consisting of 2 rounds) Delphi study was undertaken under the auspices of the executive committee of the International Ankle Consortium. The International Ankle Consortium, which was inaugurated in 2004, is an international community of researchers and clinicians whose primary academic purpose is to promote scholarship and dissemination of research-informed knowledge related to ankle sprain injury and chronic ankle instability. A previous consensus statement of the International Ankle Consortium\(^2\) and its supporting evidence document\(^1\) were utilized as the starting point for this modified Delphi study. The protocol for the present modified Delphi study, which details the study methodology, has been published.\(^{18}\) In summary, our modified Delphi process started with an anonymous online questionnaire (round 1) specifically related to the clinical assessment of acute lateral ankle sprain injuries. The online questionnaire consisted of a number of distinct sections including: (1) participant demographics; (2) subjective assessment and patient reported outcome measures; (3) diagnostic imaging; (4) objective assessment (including assessment of bony integrity, ligamentous integrity, range of motion, arthrokinematics, strength, neurodynamics, postural balance); (5) performance assessment. An email was sent to all members of the executive committee of the International Ankle Consortium requesting
their participation in the online questionnaire. Participants were required to
complete the online questionnaire within 4 weeks of receiving the invitation
email. A reminder email was sent to all participants two weeks after the initial
invitation email. Regarding the online questionnaire, participants were
requested to respond to questions related to the importance of different
constructs of the clinical assessment of acute lateral ankle sprain injuries on a
scale of 1 to 5 (1 = strongly disagree; 2 = disagree; 3 = no opinion; 4 = agree;
5 = strongly agree). They also had the opportunity to elaborate further on how
they would assess certain structures or functions by providing expanded
answers to open-ended questions. The responses to the online questionnaire
were collated, analysed (completed August 2017) and used as the foundation
for a subsequent consensus meeting of the executive committee of the
International Ankle Consortium (i.e. international multi-disciplinary expert
group). This consensus meeting (held on 14th September 2017) represented
round 2 of this modified Delphi method.

Data Analysis

Data from Round 1 were automatically extracted from the online
questionnaire to a Google Sheets document. For questions with a Likert scale
response, frequency tables were automatically generated and the level of
agreement was calculated for each response. To establish the level of
agreement, the total percentage of “Strongly Agree” (5 on the Likert Scale)
and “Agree” (4 on the Likert Scale) responses was calculated. Consensus
agreement was defined as ≥ 75%, partial agreement was defined as 50% –
75% agreement, whilst no agreement was defined as < 50%. Qualitative data
(i.e., open-ended responses to questions as part of the online questionnaire) and responses that reached partial agreement were used as discussion points in Round 2 of the modified Delphi process.

RESULTS
After two consecutive modified Delphi rounds, performed between May 2017 and September 2017, full consensus was achieved on the clinical assessment of acute lateral ankle sprain injuries (Figure 1 and Table 2).

Expert Panel
Fourteen experts from the executive committee of the International Ankle Consortium were invited to participate, all of who agreed. The expert panel (males = 84.6%, females = 15.4%; age = 45 ± 6.2 years) were employed in a number of countries including Australia, Ireland, Netherlands, Switzerland, USA and the UK. All expert panel members had authored or co-authored numerous peer-reviewed articles on the topics of lateral ankle sprain and chronic ankle instability, as well as having contributed to previous consensus statements. The years of clinical experience varied (15.7 ± 13.5 years) across the members. The expert panel members assessed an average of 40 patients a year with lateral ankle sprain injuries and/or chronic ankle instability. The expert panel members identified their expertise in the clinical assessment of patients with acute lateral ankle sprain injuries and/or chronic ankle instability as an average of 8 out of 10, with 10 being the highest level of expertise.

Delphi Round 1
All experts (100%) participated in Round 1, however answers for one participant were excluded due to technical issues. Thirteen participants successfully completed Round 1. Expert consensus (≥ 75% agreement) was reached on 37 of the 62 questions included in the online questionnaire. Fifteen criteria reached partial agreement (50% – 75%) and hence were brought forward for discussion in Round 2. Table 1 (supplementary file) details the level of agreement for each of the questions in the online questionnaire.

Delphi Round 2

Ten of the 14 expert panel members were able to attend the executive committee meeting of the International Ankle Consortium, which functioned as Round 2 of the modified Delphi process. This meeting took place the day before the 7th International Ankle Symposium (14th of September 2017).

Results from Round 1, which reached ≥ 75% agreement, were automatically included in this consensus. Results from Round 1 that reached partial agreement (50% – 75%) along with responses to open-ended questions (part of the online questionnaire) were discussed further amongst the 10 experts who were present at Round 2. To establish the level of agreement in Round 2, the total percentage of “Strongly Agree” (5 on the Likert Scale) and “Agree” (4 on the Likert Scale) responses was calculated. Consensus agreement was defined as ≥ 75%. Final consensus was reached in Round 2 and is presented in Figures 1 and Table 2.

Discussion
This modified Delphi study involving experts from the executive committee of the International Ankle Consortium reached consensus on recommendations for a guideline for clinical assessment of acute lateral ankle sprain injuries. With regard to injury diagnosis there were 5 important considerations, which the expert panel reached consensus upon. These are as follows: [1] mechanism of injury; [2] history of previous lateral ankle sprain; [3] weight-bearing status; [4] clinical assessment of bones; [5] clinical assessment of ligaments. Hence, the experts agreed that these should be clustered into a clinical diagnostic assessment.

Regarding the evaluation of mechanical and sensorimotor impairments, there were 10 important considerations, which the expert panel reached consensus upon. These are as follows: [1] pain; [2] swelling; [3] range of motion; [4] arthrokinematics; [5] muscle strength; [6] static postural balance; [7] dynamic postural balance; [8] gait; [9] physical activity level; [10] patient reported outcome measures. Hence, the experts agreed that these should be clustered and termed the International Ankle Consortium Rehabilitation-Oriented ASessment (ROAST). We advocate that clinicians should consult these recommendations as they detail an imperative first step towards the development of an appropriate management pathway for this prevalent injury.

**Clinical Diagnostic Assessment**

The expert panel agreed upon a pragmatic minimum standard clinical diagnostic assessment, which does not require specialist equipment (e.g.
diagnostic imaging) and can be applied across a range of clinical settings.

**Mechanism of Injury**

Establishing the mechanism of injury is advocated as it can give clinicians an indication of what anatomical structures are likely to have incurred insult and hence, what tissues should be prioritised during clinical assessment. Numerous published articles have described the kinematics of lateral ankle sprain injury occurrences. Clinicians should suspect injury to the lateral ligaments of the ankle joint if the patient reports that the mechanism of injury involved a sudden rapid inversion and internal rotation loading of the foot and ankle complex, irrespective of sagittal plane angular displacement. The mechanisms of injury associated with ankle syndesmosis ligament injuries are less clear, but have been reported to include external rotation of the foot, eversion of the talus within the ankle mortise and excessive dorsiflexion. Therefore, clinicians should suspect injury to the syndesmosis ligaments if the patient describes/recalls any of the aforementioned injury mechanisms (i.e. external rotation of the foot, hyper-dorsiflexion).

**History of Previous Lateral Ankle Sprain**

Establishing history of previous lateral ankle sprain injury or ankle joint injury is endorsed primarily for two reasons. Firstly, it has been established that previous lateral ankle sprain injury heightens the risk of injury recurrence. Secondly, if the presenting patient has previously sustained a lateral ankle
sprain injury, it is probable that injury-associated mechanical and sensorimotor impairments are present, which should be addressed as part of a comprehensive rehabilitation programme.

**Weight-bearing Status**

Weight-bearing status should be established, both via subjective reporting related to the time of injury, and during clinical presentation in accordance with the Ottawa Ankle Rules. An inability to weight-bear four steps immediately after injury and upon clinical presentation should alert clinicians to the possibility of ankle joint fracture. The likelihood of ankle joint fracture can be established with high sensitivity by utilizing the Ottawa Ankle Rules, whereby, weight-bearing status and clinical assessment of the "malleolar zone" are combined in a clinical prediction rule.  

**Clinical Assessment of Bones**

The Ottawa Ankle Rules should be utilised to determine the likelihood of ankle joint fracture. If a patient reports pain in the "malleolar zone" and if this is accompanied by pain on palpation of the distal 6 cm of the posterior edge of the medial malleolus, or pain on palpation of the distal 6 cm of the posterior edge of the lateral malleolus, or an inability to weight-bear four steps immediately after injury and upon clinical presentation, then an ankle joint X-ray is warranted (appendix I). The Ottawa Ankle Rules have been reported to have higher sensitivity than specificity, meaning that they are better at ruling out the possibility of ankle joint fracture, rather than making a diagnosis of ankle joint fracture. Following an inversion and internal rotation injury of the
ankle joint the pre-test probability of ankle joint fracture is less than 15%.\textsuperscript{30} If
the Ottawa Ankle Rules are implemented in such instances but findings are
negative (i.e. none of the rules are positive; negative likelihood ratio = 0.02),
the post-test probability of ankle joint fracture is less than 1%.

**Clinical Assessment of Ligaments**

The clinical assessment of the integrity of the lateral ligaments of the ankle
joint, as well as the ankle joint syndesmosis ligaments is advocated. The main
lateral ligamentous stabilizers of the ankle joint are: the anterior talofibular
ligament, the calcaneofibular ligament and the posterior talofibular ligament.
The anterior talofibular ligament is the most commonly injured of these
ligaments.\textsuperscript{31} It originates at the anterior margin of the lateral malleolus and it
runs anteromedially to insert on the talar body immediately anterior to the joint
surface occupied by the lateral malleolus.\textsuperscript{32} Replication of the patient's
“known pain” upon palpation and/or stressing (i.e. passive plantar flexion and
inversion) of the anterior talofibular ligament is indicative of injury to this
ligament (\textit{appendix I}). Clinical stability tests to assess for complete disruption
of the anterior talofibular ligament are best performed between 4 and 6 days
after injury.\textsuperscript{33} The anterior drawer test is the most sensitive clinical stability
test to assess for complete rupture of the anterior talofibular ligament.\textsuperscript{33} The
sensitivity and specificity of this test are 0.96 and 0.84 respectively, with an
associated negative likelihood ratio of 0.04.\textsuperscript{33} This means that if there is no “sulcus sign” upon testing the integrity of the anterior talofibular ligament using the anterior drawer test then there is low probability that it is completely disrupted/ruptured (appendix I).

The calcaneofibular ligament originates from the anterior part of the lateral malleolus and courses obliquely downwards and backwards to attach to the posterior region of the lateral calcaneal surface.\textsuperscript{32} It is superficially crossed by the peroneal tendons and sheaths, with only approximately 1 cm of the ligament being uncovered and directly palpable. Replication of the patient’s “known pain” upon palpation and/or stressing (i.e. passive dorsiflexion of the ankle joint combined with passive inversion of the rearfoot) of the calcaneofibular ligament is indicative of injury to this ligament (appendix I).

The prevalence of ankle joint syndesmosis ligament injury (with or without concomitant lateral ligament involvement) has been reported to be 20%.\textsuperscript{31} As such, it is important to undertake a clinical assessment of the ankle joint syndesmosis ligaments. Sman and colleagues\textsuperscript{34} have reported that localized tenderness upon palpation of the syndesmosis ligaments is the most sensitive clinical assessment test (sensitivity = 0.92), whilst the squeeze test is the most specific clinical assessment test (specificity = 0.88). Thus, if the most sensitive clinical assessment test (palpation of the syndesmosis ligaments) and the most specific clinical assessment test (squeeze test) are positive, there is a high probability of injury to the syndesmosis ligaments (appendix I).

International Ankle Consortium Rehabilitation-Oriented ASsessmenT (ROAST)
The expert panel agreed upon a rehabilitation-oriented assessment, with the primary purpose of identifying the presence of mechanical and/or sensorimotor impairments that are known to contribute to the development of chronic ankle instability. To determine the true presence of these impairments in the acute phase following injury clinicians can utilize the non-injured side as a comparator.

**Pain**

Quantification of a patient’s current self-reported ankle joint pain is endorsed. Self-reported pain should be used as a clinically oriented outcome measure to guide the progression of exercise-based rehabilitation and to assess the efficacy of treatments implemented. Numerous options exist for assessing ankle joint pain in clinical settings. The numeric rating scale for pain is a valid and reliable scale to measure pain intensity. It can be administered both verbally and in writing and can be used to quantify pain during various activities. However, it only evaluates one component of the pain experience, namely, pain intensity. The assessment of ankle-specific pain is a central component of the Foot and Ankle Disability Index (appendix I), which is a patient reported outcome questionnaire designed to assess functional limitations related to foot and ankle conditions.

**Swelling**
The assessment of ankle joint swelling is advocated. Ankle joint swelling may alter somatosensory input to the central nervous system, which, through the process of arthrogenic muscle inhibition could negatively affect functional joint stability.\(^{37}\) The quantification of ankle joint swelling should be used as a clinically oriented outcome measure to direct exercise-based rehabilitation progression and to measure the efficacy of therapeutic interventions. The figure-of-eight method has been reported to be a valid and reliable clinically applicable method for indirectly quantifying ankle joint swelling (appendix I).\(^{38}\)\(^{41}\)

**Range of Motion**

A comprehensive assessment of both passive and active ankle joint range of motion is endorsed. The quantification of ankle joint range of motion should be used as a clinically oriented outcome measure to guide exercise-based rehabilitation progression and to gauge the efficacy of therapeutic interventions. Of particular concern following lateral ankle sprain injury is the propensity for the development of a restriction in ankle joint dorsiflexion range of motion.\(^{42}\) Sufficient ankle joint dorsiflexion range of motion is important as it has been reported to explain up to 28% of the variance in dynamic postural stability performance, as assessed via the anterior reach direction of the Star Excursion Balance Test.\(^{43}\) The weight-bearing lunge test is a clinically applicable, valid and reliable method for assessing ankle joint dorsiflexion range of motion (appendix I).\(^{44-46}\)
Arthrokinematics

Assessment of talocrural joint arthrokinematics is advocated. It has been proposed that impairments in ankle joint dorsiflexion range of motion are likely related to a disruption in talocrural arthrokinematics.\textsuperscript{16} This is supported by studies that have reported either restrictions in posterior talar glide,\textsuperscript{47,48} or the existence of an anterior positional fault of the talus within the talocrural joint.\textsuperscript{49,50} The posterior talar glide test as reported by Denegar et al\textsuperscript{48} can be used to assess posterior glide of the talus within the talocrural joint.

Muscle Strength

Assessment of ankle joint muscle strength is advocated. During the contractile process, musculotendinous units generate stiffness, resulting in dynamic protection of joints. A strength deficit of the ankle musculature could compromise the integrity of the ankle joint to withstand sudden injurious movements. Individuals with chronic ankle instability have been reported to exhibit deficits in ankle joint strength.\textsuperscript{51} Muscle strength can be measured objectively using isokinetic dynamometers and hand-held dynamometers. A hand-held dynamometer offers a practical clinically applicable alternative to isokinetic dynamometry due to it's portability, reduced cost and convenient size.\textsuperscript{52} Ankle joint strength can be measured in an objective and reliable manner using hand-held dynamometry (appendix I).\textsuperscript{53} Additionally, there is
evidence to suggest that hip strength may be an important factor to also consider, as research has identified proximal strength deficits in individuals with chronic ankle instability.  

**Static Postural Balance**

Assessing static postural balance is endorsed as an integral component of a rehabilitation-oriented clinical assessment following lateral ankle sprain injury. Deficiencies in static postural stability have been consistently identified in individuals with chronic ankle instability. Both the Balance Error Scoring System and the Foot Lift Test are clinically applicable methods for assessing static postural balance (appendix I).

**Dynamic Postural Balance**

Assessing dynamic postural balance is endorsed as a central component of a rehabilitation-oriented clinical assessment following lateral ankle sprain injury. Impairments in dynamic postural balance performance have been steadfastly identified in individuals with chronic ankle instability. The Star Excursion Balance Test can be readily used in the clinic to assess dynamic postural balance performance (appendix I).

**Gait**

Assessment of walking gait is endorsed following acute lateral ankle sprain injury. It has been posited that the high potential for lateral ankle sprain injury recurrence during gait is likely due to inappropriate positioning of the lower
extremity joints in the loading-unloading transitions between stance and swing.\textsuperscript{59,60} Aberrancies in lower extremity biomechanics during walking gait have been consistently identified in individuals with chronic ankle instability.\textsuperscript{61,62}

**Physical Activity Level**

Establishing the patient’s level of physical activity prior to incurring their lateral ankle sprain injury is endorsed primarily for two reasons. Firstly, it can help guide the specificity of exercise-based rehabilitation. Secondly, it can be used to establish whether the patient has returned to his/her pre-injury participation level. An example of an appropriate questionnaire is the Tegner activity-level scale (appendix I).\textsuperscript{63}

**Patient Reported Outcome Measures**

Patient reported outcome measures improve the quality of assessing and reporting the outcome of treatments and their use as part of a rehabilitation-oriented clinical assessment following lateral ankle sprain injury is advocated. A number of patient reported outcome measures exist which have been commonly used with individuals with chronic ankle instability.\textsuperscript{64} Examples of appropriate patient reported outcome measures to assess function of the ankle include the Foot and Ankle Disability Index,\textsuperscript{36} and the Foot and Ankle Ability Measure (appendix I).\textsuperscript{65}

**Future research**
High-quality prospective research is needed to determine whether these recommendations constitute a guideline for clinical assessment of acute lateral ankle sprain injuries can optimize the management of individuals who have incurred this injury.

CONCLUSION

The A panel of experts (i.e. the executive committee of the International Ankle Consortium) reached consensus on recommendations as a guideline for structured clinical assessment of acute lateral ankle sprain injuries. Recommendations are provided on an initial diagnostic clinical assessment. The International Ankle Consortium ROAST is also presented, which places emphasis on the assessment of mechanical and sensorimotor impairments that are known to associate with chronic ankle instability.

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<tr>
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<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
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<td>11</td>
<td>11 (84.6%)</td>
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<tr>
<td><strong>Posterior edge of the fibula</strong></td>
<td>0 (0.0%)</td>
<td>1 (7.7%)</td>
<td>1 (7.7%)</td>
<td>3</td>
<td>8</td>
<td>8 (61.6%)</td>
</tr>
<tr>
<td><strong>Tip of the medial malleolus</strong></td>
<td>0 (0.0%)</td>
<td>1 (7.7%)</td>
<td>4 (30.8%)</td>
<td>4</td>
<td>3</td>
<td>3 (21.3%)</td>
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<tr>
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<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>4</td>
<td>9</td>
<td>9 (69.2%)</td>
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<tr>
<td><strong>Tip of the lateral</strong></td>
<td>0 (0.0%)</td>
<td>4 (26.3%)</td>
<td>4 (26.3%)</td>
<td>4</td>
<td>8</td>
<td>8 (61.6%)</td>
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Table 1. Result of modified Delphi Round 1
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<th></th>
<th>0 (0.0%)</th>
<th>0 (0.0%)</th>
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<th>4 (30.8%)</th>
<th>8 (53.8%)</th>
<th>84.6</th>
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<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
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<td>38.5</td>
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<td>0 (0.0%)</td>
<td>5 (38.5%)</td>
<td>2 (15.4%)</td>
<td>3 (23.1%)</td>
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<tr>
<td>Active plantar flexion</td>
<td>0 (0.0%)</td>
<td>2 (15.4%)</td>
<td>0 (0.0%)</td>
<td>5 (38.5%)</td>
<td>8 (61.5%)</td>
<td>84.6</td>
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<tr>
<td>Passive inversion</td>
<td>0 (0.0%)</td>
<td>2 (15.4%)</td>
<td>0 (0.0%)</td>
<td>5 (38.5%)</td>
<td>8 (61.5%)</td>
<td>84.6</td>
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<tr>
<td>Active eversion</td>
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<td>2 (15.4%)</td>
<td>0 (0.0%)</td>
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<td>8 (61.5%)</td>
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<tr>
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<td>0 (0.0%)</td>
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<td>8 (61.5%)</td>
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<td>Passive inversion</td>
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<td>0 (0.0%)</td>
<td>5 (38.5%)</td>
<td>8 (61.5%)</td>
<td>84.6</td>
</tr>
<tr>
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<td>8 (61.5%)</td>
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<td>6 (46.2%)</td>
<td>77</td>
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<tr>
<td>of the Ankle Joint</td>
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<tr>
<td>Antero-posterior glide of inferior tibiofibular joint</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
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<tr>
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<tr>
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<tr>
<td>Postero-anterior glide of the superior tibiofibular joint</td>
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<td>2 (15.4%)</td>
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<td>0 (0.0%)</td>
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<td>3 (23.1%)</td>
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<td>Lower Extremity Muscles Assessment</td>
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<td>2 (15.4%)</td>
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<td>Count</td>
<td>Percentage</td>
<td>Count</td>
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<td>2 (15.4%)</td>
<td>4 (30.8%)</td>
<td>4 (30.8%)</td>
<td>2 (15.4%)</td>
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<tr>
<td>the ankle joint</td>
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<td>Assessment of Nerves</td>
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<td>4 (30.8%)</td>
<td>5 (38.5%)</td>
<td>1 (7.7%)</td>
<td>46.2%</td>
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<tr>
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<td>3 (23.1%)</td>
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<td>15.4%</td>
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<td>2 (15.4%)</td>
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<td>Sensorimotor Function</td>
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<td>1 (7.7%)</td>
<td>1 (7.7%)</td>
<td>10 (76.9%)</td>
<td>84.6%</td>
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<tr>
<td>Static postural balance</td>
<td>0 (0.0%)</td>
<td>2 (15.4%)</td>
<td>2 (15.4%)</td>
<td>3 (23.1%)</td>
<td>6 (46.2%)</td>
<td>69.2%</td>
</tr>
<tr>
<td>Dynamic postural balance</td>
<td>0 (0.0%)</td>
<td>1 (7.7%)</td>
<td>1 (7.7%)</td>
<td>2 (15.4%)</td>
<td>9 (69.2%)</td>
<td>84.6%</td>
</tr>
<tr>
<td>Proprioception</td>
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<td>3 (23.1%)</td>
<td>4 (30.8%)</td>
<td>3 (23.1%)</td>
<td>53.8%</td>
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<td>8 (64.6%)</td>
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<td>84.6%</td>
</tr>
<tr>
<td>Functional performance testing</td>
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<td>0 (0.0%)</td>
<td>2 (15.4%)</td>
<td>3 (23.1%)</td>
<td>8 (61.5%)</td>
<td>84.6%</td>
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</tbody>
</table>
Table 2. International Ankle Consortium Rehabilitation-Oriented ASsessmenT (ROAST)

<table>
<thead>
<tr>
<th>What clinicians should assess following acute lateral ankle sprain injury</th>
<th>Why?</th>
<th>How?</th>
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<tr>
<td>Ankle joint swelling</td>
<td>Swelling can cause arthrogenic muscle inhibition. Guide progression of exercise-based rehabilitation. Evaluate the efficacy of treatments implemented.</td>
<td>Figure-of-eight[^30]</td>
</tr>
<tr>
<td>Ankle joint range of motion</td>
<td>High propensity for the development of a dorsiflexion deficit. Impairments in ankle joint range of motion are consistently identified in individuals with CAI.</td>
<td>Weight-bearing lunge test[^45][^46]</td>
</tr>
<tr>
<td>Ankle joint arthrokinematics</td>
<td>Disruption in ankle joint arthrokinematics can result in a dorsiflexion deficit. Impairments in ankle joint arthrokinematics are regularly identified in individuals with CAI.</td>
<td>Posterior talar glide test[^20]</td>
</tr>
<tr>
<td>Ankle joint muscle strength</td>
<td>Impairments in ankle joint strength compromise the functional integrity of the ankle joint. Impairments in ankle joint strength are regularly identified in individuals with CAI.</td>
<td>Hand-held dynamometry[^27]</td>
</tr>
<tr>
<td>Static postural balance</td>
<td>Impairments in static postural balance are consistently identified in individuals with CAI.</td>
<td>BESS[^50] FLT[^51]</td>
</tr>
<tr>
<td>Dynamic postural balance</td>
<td>Impairments in dynamic postural balance are consistently identified in individuals with CAI.</td>
<td>SEBT[^58]</td>
</tr>
<tr>
<td>Gait</td>
<td>Impairments in gait are consistently identified in individuals with CAI.</td>
<td>Visual assessment for antalgic gait</td>
</tr>
<tr>
<td>Physical activity level</td>
<td>Impairments in exercise-based rehabilitation.</td>
<td>Tegner activity-level scale[^27]</td>
</tr>
<tr>
<td>Ankle joint specific patient reported outcome measures</td>
<td>Evaluate the efficacy of treatments implemented.</td>
<td>FADI[^36] FAAM[^65]</td>
</tr>
</tbody>
</table>

FADI = Foot and Ankle Disability Index; CAI = chronic ankle instability; BESS = Balance Error Scoring System; FLT = Foot Lift Test; SEBT = Star Excursion Balance Test; FAAM = Foot and Ankle Ability Measure.
Caption: Figure 1. Clinical Diagnostic Assessment

Legend: ATFL = anterior talofibular ligament; CFL = calcaneofibular ligament

60x45mm (300 x 300 DPI)
<table>
<thead>
<tr>
<th>Subjective Assessment</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>No Opinion</th>
<th>Agree</th>
<th>Strongly Agree</th>
<th>Percentage of Agreement (≥ 75% = consensus)</th>
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<tr>
<td>Subjective Assessment</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>4 (30.8%)</td>
<td>9 (69.2%)</td>
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<tr>
<td>Mechanism of injury</td>
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<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>6 (46.2%)</td>
<td>7 (53.8%)</td>
<td>100</td>
</tr>
<tr>
<td>Pain</td>
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<td>0 (0.0%)</td>
<td>1 (7.7%)</td>
<td>6 (46.2%)</td>
<td>6 (46.2%)</td>
<td>92.4</td>
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<tr>
<td>Swelling at time of injury</td>
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<td>0 (0.0%)</td>
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<td>8 (61.5%)</td>
<td>2 (15.4%)</td>
<td>76.9</td>
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<tr>
<td>Hotness</td>
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<td>6 (46.2%)</td>
<td>6 (46.2%)</td>
<td>0 (0.0%)</td>
<td>46.2</td>
</tr>
<tr>
<td>Discoloration</td>
<td>0 (0.0%)</td>
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<td>1 (7.7%)</td>
<td>7 (53.8%)</td>
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<td>76.9</td>
</tr>
<tr>
<td>Weight-bearing status at time of injury</td>
<td>0 (0.0%)</td>
<td>1 (7.7%)</td>
<td>1 (7.7%)</td>
<td>3 (23.1%)</td>
<td>8 (61.5%)</td>
<td>84.6</td>
</tr>
<tr>
<td>Weight-bearing status at clinical presentation</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>3 (23.1%)</td>
<td>10 (76.9%)</td>
<td>100</td>
</tr>
<tr>
<td>History of previous lateral ankle sprain injury</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>2 (15.4%)</td>
<td>11 (84.6%)</td>
<td>100</td>
</tr>
<tr>
<td>History of previous lower limb injury</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>2 (15.4%)</td>
<td>6 (46.2%)</td>
<td>5 (38.5%)</td>
<td>84.6</td>
</tr>
<tr>
<td>History of other injuries</td>
<td>0 (0.0%)</td>
<td>1 (7.7%)</td>
<td>4 (30.8%)</td>
<td>5 (38.5%)</td>
<td>3 (23.1%)</td>
<td>61.6</td>
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<tr>
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<td>69.2</td>
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<tr>
<td>Physical activity level</td>
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<td>0 (0.0%)</td>
<td>2 (15.4%)</td>
<td>3 (23.1%)</td>
<td>8 (61.5%)</td>
<td>84.6</td>
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<tr>
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<td>2 (15.4%)</td>
<td>69.2</td>
</tr>
<tr>
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<td>5 (38.5%)</td>
<td>5 (38.5%)</td>
<td>77</td>
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<tr>
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<td>4 (30.8%)</td>
<td>4 (30.8%)</td>
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<td>3 (23.1%)</td>
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<tr>
<td>Palpating Bones</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>2 (15.4%)</td>
<td>11 (84.6%)</td>
<td>100</td>
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<td>0 (0.0%)</td>
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<td>1 (7.7%)</td>
<td>3 (23.1%)</td>
<td>8 (61.5%)</td>
<td>84.6</td>
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<tr>
<td>Tip of the medial malleolous</td>
<td>0 (0.0%)</td>
<td>1 (7.7%)</td>
<td>4 (30.8%)</td>
<td>1 (7.7%)</td>
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<td>61.5</td>
</tr>
<tr>
<td>Posterior edge of the fibula</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>4 (30.8%)</td>
<td>9 (69.2%)</td>
<td>100</td>
</tr>
<tr>
<td>Tip of the lateral malleolous</td>
<td>0 (0.0%)</td>
<td>1 (7.7%)</td>
<td>1 (7.7%)</td>
<td>3 (23.1%)</td>
<td>8 (61.5%)</td>
<td>84.6</td>
</tr>
<tr>
<td>Base of the 5th metatarsal</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>2 (15.4%)</td>
<td>4 (30.8%)</td>
<td>7 (53.8%)</td>
<td>84.6</td>
</tr>
<tr>
<td></td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>5 (38.5%)</td>
<td>1 (7.7%)</td>
<td>7 (53.8%)</td>
<td>61.5</td>
</tr>
<tr>
<td>------------------</td>
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<td>------</td>
</tr>
<tr>
<td><strong>Navicular</strong></td>
<td>0(0.0%)</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>2</td>
<td>11</td>
<td>100</td>
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<tr>
<td><strong>Ligamentous</strong></td>
<td></td>
<td></td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td><strong>Integrity</strong></td>
<td></td>
<td></td>
<td>1 (7.7%)</td>
<td>5 (38.5%)</td>
<td>2</td>
<td>38.5</td>
</tr>
<tr>
<td><strong>Anterior talofibular ligament</strong></td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>3 (23.1%)</td>
<td>10 (76.9%)</td>
<td>100</td>
</tr>
<tr>
<td><strong>Cuneaneofibular ligament</strong></td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>4 (30.8%)</td>
<td>9 (69.2%)</td>
<td>100</td>
</tr>
<tr>
<td><strong>Posterior talofibular ligament</strong></td>
<td>0 (0.0%)</td>
<td>3 (23.1%)</td>
<td>5 (38.5%)</td>
<td>2 (15.4%)</td>
<td>3 (23.1%)</td>
<td>38.5</td>
</tr>
<tr>
<td><strong>Syndesmosis ligaments</strong></td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>1 (7.7%)</td>
<td>5 (38.5%)</td>
<td>7 (53.8%)</td>
<td>92.3</td>
</tr>
<tr>
<td><strong>Range of Motion</strong></td>
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<td>2 (15.4%)</td>
<td>0 (0.0%)</td>
<td>3 (23.1%)</td>
<td>8 (61.5%)</td>
<td>84.6</td>
</tr>
<tr>
<td><strong>Active dorsiflexion</strong></td>
<td>0 (0.0%)</td>
<td>1 (7.7%)</td>
<td>1 (7.7%)</td>
<td>5 (38.5%)</td>
<td>6 (46.2%)</td>
<td>84.6</td>
</tr>
<tr>
<td><strong>Active plantar flexion</strong></td>
<td>0 (0.0%)</td>
<td>2 (15.4%)</td>
<td>1 (7.7%)</td>
<td>6 (46.2%)</td>
<td>4 (30.8%)</td>
<td>77</td>
</tr>
<tr>
<td><strong>Active inversion</strong></td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>2 (15.4%)</td>
<td>7 (53.8%)</td>
<td>4 (30.8%)</td>
<td>84.6</td>
</tr>
<tr>
<td><strong>Active eversion</strong></td>
<td>0 (0.0%)</td>
<td>1 (7.7%)</td>
<td>0 (0.0%)</td>
<td>8 (61.5%)</td>
<td>4 (30.8%)</td>
<td>92.3</td>
</tr>
<tr>
<td><strong>Passive dorsiflexion</strong></td>
<td>0 (0.0%)</td>
<td>1 (7.7%)</td>
<td>0 (0.0%)</td>
<td>8 (61.5%)</td>
<td>4 (30.8%)</td>
<td>84.6</td>
</tr>
<tr>
<td><strong>Passive plantar flexion</strong></td>
<td>0 (0.0%)</td>
<td>2 (15.4%)</td>
<td>1 (7.7%)</td>
<td>6 (46.2%)</td>
<td>4 (30.8%)</td>
<td>84.6</td>
</tr>
<tr>
<td><strong>Passive inversion</strong></td>
<td>0 (0.0%)</td>
<td>1 (7.7%)</td>
<td>2 (15.4%)</td>
<td>7 (53.8%)</td>
<td>3 (23.1%)</td>
<td>77</td>
</tr>
<tr>
<td><strong>Passive eversion</strong></td>
<td>0 (0.0%)</td>
<td>1 (7.7%)</td>
<td>2 (15.4%)</td>
<td>7 (53.8%)</td>
<td>3 (23.1%)</td>
<td>84.6</td>
</tr>
<tr>
<td><strong>Mobility of the first ray</strong></td>
<td>1 (7.7%)</td>
<td>2 (15.4%)</td>
<td>4 (30.8%)</td>
<td>5 (38.5%)</td>
<td>1 (7.7%)</td>
<td>46.2</td>
</tr>
<tr>
<td><strong>Arthrokinematics of the Ankle Joint</strong></td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>3 (23.1%)</td>
<td>4 (30.8%)</td>
<td>6 (46.2%)</td>
<td>77</td>
</tr>
<tr>
<td><strong>Antero-posterior glide of inferior tibiofibular joint</strong></td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>5 (38.5%)</td>
<td>6 (46.2%)</td>
<td>2 (15.4%)</td>
<td>61.5</td>
</tr>
<tr>
<td><strong>Postero-anterior glide of the inferior tibiofibular joint</strong></td>
<td>1 (7.7%)</td>
<td>0 (0.0%)</td>
<td>4 (30.8%)</td>
<td>6 (46.2%)</td>
<td>2 (15.4%)</td>
<td>61.5</td>
</tr>
<tr>
<td><strong>Antero-posterior glide of the superior tibiofibular Joint</strong></td>
<td>0 (0.0%)</td>
<td>1 (7.7%)</td>
<td>5 (38.5%)</td>
<td>6 (46.2%)</td>
<td>1 (7.7%)</td>
<td>53.8</td>
</tr>
<tr>
<td><strong>Postero-anterior glide of the superior tibiofibular joint</strong></td>
<td>1 (7.7%)</td>
<td>0 (0.0%)</td>
<td>4 (30.8%)</td>
<td>6 (46.2%)</td>
<td>2 (15.4%)</td>
<td>61.5</td>
</tr>
<tr>
<td><strong>Antero-posterior glide of the talus</strong></td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>3 (23.1%)</td>
<td>3 (23.1%)</td>
<td>7 (53.8%)</td>
<td>77</td>
</tr>
<tr>
<td><strong>Lower Extremity Muscles Assessment</strong></td>
<td>0 (0.0%)</td>
<td>1 (7.7%)</td>
<td>1 (7.7%)</td>
<td>8 (61.5%)</td>
<td>3 (23.1%)</td>
<td>84.6</td>
</tr>
<tr>
<td><strong>Palpation of the muscles of the ankle joint</strong></td>
<td>0 (0.0%)</td>
<td>2 (15.4%)</td>
<td>2 (15.4%)</td>
<td>5 (38.5%)</td>
<td>4 (30.8%)</td>
<td>69.2</td>
</tr>
<tr>
<td><strong>Palpation of the intrinsic foot muscles</strong></td>
<td>0 (0.0%)</td>
<td>5 (38.5%)</td>
<td>3 (23.1%)</td>
<td>4 (30.8%)</td>
<td>1 (7.7%)</td>
<td>38.5</td>
</tr>
<tr>
<td><strong>Length testing of the muscles of the ankle joint</strong></td>
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<td>2 (15.4%)</td>
<td>4 (30.8%)</td>
<td>4 (30.8%)</td>
<td>2 (15.4%)</td>
<td>61.5</td>
</tr>
<tr>
<td><strong>Strength testing of the</strong></td>
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<td>0 (0.0%)</td>
<td>1 (8.3%)</td>
<td>7 (33.3%)</td>
<td>4 (33.3%)</td>
<td>91.7</td>
</tr>
<tr>
<td>Assessment of Nerves</td>
<td>1 (7.7%)</td>
<td>2 (15.4%)</td>
<td>4 (30.8%)</td>
<td>5 (38.5%)</td>
<td>1 (7.7%)</td>
<td>46.2</td>
</tr>
<tr>
<td>---------------------</td>
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</tr>
<tr>
<td>Palpation of lower extremity nerves</td>
<td>2 (15.4%)</td>
<td>3 (23.1%)</td>
<td>6 (46.2%)</td>
<td>2 (15.4%)</td>
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<td>15.4</td>
</tr>
<tr>
<td>Lower limb neurodynamics testing</td>
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<td>4 (30.8%)</td>
<td>5 (38.5%)</td>
<td>2 (15.4%)</td>
<td>1 (7.7%)</td>
<td>23.1</td>
</tr>
<tr>
<td>Sensorimotor Function</td>
<td>0 (0.0%)</td>
<td>1 (7.7%)</td>
<td>1 (7.7%)</td>
<td>1 (7.7%)</td>
<td>10 (76.9%)</td>
<td>84.6</td>
</tr>
<tr>
<td>Static postural balance</td>
<td>0 (0.0%)</td>
<td>2 (15.4%)</td>
<td>2 (15.4%)</td>
<td>3 (23.1%)</td>
<td>6 (46.2%)</td>
<td>69.2</td>
</tr>
<tr>
<td>Dynamic postural balance</td>
<td>0 (0.0%)</td>
<td>1 (7.7%)</td>
<td>1 (7.7%)</td>
<td>2 (15.4%)</td>
<td>9 (69.2%)</td>
<td>84.6</td>
</tr>
<tr>
<td>Proprioception</td>
<td>0 (0.0%)</td>
<td>3 (23.1%)</td>
<td>3 (23.1%)</td>
<td>4 (30.8%)</td>
<td>3 (23.1%)</td>
<td>53.8</td>
</tr>
<tr>
<td>Performance Assessment</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>1 (7.7%)</td>
<td>2 (15.4%)</td>
<td>10 (76.9%)</td>
<td>92.3</td>
</tr>
<tr>
<td>Gait analysis</td>
<td>0 (0.0%)</td>
<td>1 (7.7%)</td>
<td>1 (7.7%)</td>
<td>8 (61.5%)</td>
<td>3 (23.1%)</td>
<td>84.6</td>
</tr>
<tr>
<td>Functional performance testing</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>2 (15.4%)</td>
<td>3 (23.1%)</td>
<td>8 (61.5%)</td>
<td>84.6</td>
</tr>
</tbody>
</table>
Appendix I
Ottawa Ankle Rules

Ottawa Ankle Rules palpation points (Figure 1 and 2):
Lateral view showing the distal 6 cm of the posterior edge of the lateral malleolus (Figure 1).
Medial view showing the distal 6 cm of the posterior edge of the medial malleolus (Figure 2).

Clinical interpretation:
If a patient reports pain in the “malleolar zone” and if this is accompanied by pain on palpation of the distal 6 cm of the posterior edge of the medial malleolus, or pain on palpation of the distal 6 cm of the posterior edge of the lateral malleolus, or an inability to weight-bear four steps immediately after injury and upon clinical presentation, then an ankle joint X-ray is warranted.

Figure 1. Lateral view showing the distal 6 cm of the posterior edge of the lateral malleolus.
Figure 2. Medial view showing the distal 6 cm of the posterior edge of the medial malleolus.
Anterior talofibular ligament palpation

Recommended position for palpating the anterior talofibular ligament (Figure 3):
With the ankle joint plantar flexed and the foot inverted and internally rotated the clinician can palpate the anterior talofibular ligament at its attachment to the distal tip of the lateral malleolus.

Clinical assessment:
The ligament is subcutaneous and can be palpated at its origin at the anterior margin of the distal tip of the lateral malleolus.

Clinical interpretation:
Replication of the patient’s “known pain” upon palpation of the anterior talofibular ligament is indicative of injury to this ligament.

Figure 3. The left index finger of the clinician is positioned at the distal tip of the lateral malleolus and is palpating the fibular attachment of the anterior talofibular ligament. The ankle joint is positioned in plantar flexion whilst the foot is inverted and internally rotated.
Anterior talofibular ligament stress test

Recommended position for “stressing” the anterior talofibular ligament (Figure 4):
The ankle joint is passively plantar flexed whilst the foot is passively inverted and internally rotated.

Clinical assessment:
The anterior talofibular stress test is performed by passively moving the ankle joint into plantar flexion combined with inversion and internal rotation of the foot.

Clinical interpretation:
Replication of the patient’s “known pain” upon “stressing” of the anterior talofibular ligament is indicative of injury to this ligament.

Figure 4. In this figure the clinician has passively plantar flexed the ankle joint and has also passively inverted and internally rotated the foot.
Anterior talofibular ligament anterior drawer test

Recommended position for performing the anterior talofibular ligament anterior drawer test (Figure 5 and 6):
Start position (Figure 5)
Presence of a “sulcus sign” (Figure 6)

Clinical interpretation: The anterior talofibular ligament anterior drawer test can be used to determine whether the anterior talofibular ligament is completely disrupted/ruptured. The presence of a “sulcus sign” is indicative of complete disruption/rupture.

Figure 5. Start position for performing the anterior drawer test.
Figure 6. Presence of a “sulcus sign”. This figure illustrates the end position of an anterior drawer test. A clear “sulcus sign” is identified anterior to the lateral malleolus.
Calcaneofibular ligament palpation

*Recommended position for palpating the calcaneofibular ligament (Figure 7):* The patient is positioned in side-lying. The calcaneofibular ligament is palpated along a line directed at 135° oriented from the tip of the lateral malleolus to the posterior-lateral edge of the calcaneus.

**Clinical assessment:**
The distal portion of the ligament is subcutaneous and can be palpated distal to the peroneal tendons.

**Clinical interpretation:**
Replication of the patient’s “known pain” upon palpation of the calcaneofibular ligament is indicative of injury to this ligament.

![Image of calcaneofibular ligament palpation](https://mc.manuscriptcentral.com/bjsm)

*Figure 7. The index finger of the clinician is positioned on a portion of the calcaneofibular ligament just distal to the peroneal tendons.*
Syndesmosis ligament palpation

*Recommended position for palpating the syndesmosis (Figure 8):* The anterior inferior tibiofibular ligament portion of the ankle joint syndesmosis ligament complex can be palpated at the anterior margin of the ankle joint.

Clinical assessment:
The syndesmosis ligament can be palpated at the anterior margin of the ankle joint.

Clinical interpretation:
Replication of the patient’s “known pain” upon palpation of the syndesmosis ligament is indicative of injury to this ligament.

Figure 8. The clinician’s thumb is positioned on a portion of the anterior tibiofibular ligament.
Syndesmosis squeeze test

Recommended position for performing the syndesmosis squeeze test (Figure 9):
The syndesmosis squeeze test is performed with the patient in supine lying.

Clinical assessment:
The syndesmosis squeeze test is performed by stabilizing the tibia whilst simultaneous approximating (i.e. squeezing) the proximal fibula against the tibia.

Clinical interpretation:
Replication of the patient’s “known pain” is indicative of injury to this ligament.

Figure 9. The tibia is stabilized whilst the fibula is approximated (“squeezed”) against the tibia.
Ankle joint swelling

Recommended position for performing the figure-of-eight method of ankle swelling measurement (Figure 10 and 11):

Clinical assessment:
The measurement is performed as follows: (1) the beginning of the measuring tape is placed midway between the tibialis anterior tendon and lateral malleolus; (2) it is drawn in a medial direction across the instep just distal to the tuberosity of the navicular; (3) it is then pulled across the plantar aspect of the foot to a point just proximal to the base of the 5th metatarsal; (4) it is then pulled across the tibialis anterior tendon and around the ankle joint below the distal tip of the medial malleolus; (5) it is then pulled around the Achilles tendon and distal to the lateral malleolus; (6) to complete the figure-of-eight the measuring tape is pulled to the starting point.

![Ankle Measurement](image)

Figure 10. Lateral view of the figure-of-eight method of ankle swelling measurement.
Figure 11. Anterior-medial view of the figure-of-eight method of ankle swelling measurement.
Weight-bearing lunge test

*Recommended position for performing the weight-bearing lunge test (Figure 12 and 13):*

*Clinical assessment:*
To perform this test the patient lunges forward trying to touch a vertical line on the wall with their knee while maintaining their test foot and heel in contact with the ground (i.e. foot flat position). The contralateral limb is positioned behind the testing limb in a comfortable position whilst the patient’s hands are placed on the wall. To find the position of maximum dorsiflexion the clinician guides the patient to move their test foot away from the wall in small increments with the objective of maintaining knee contact with the wall and a foot flat position. The final position before knee contact in a foot flat position cannot be maintained is classified as maximum dorsiflexion. The distance from the tip of the great toe to the wall is measured in this position.
Figure 12. Posterior-lateral view of the weight-bearing lunge test.
Figure 13. Medial view of the weight-bearing lunge test.
Ankle joint eversion strength test

Recommended position for testing isometric ankle joint eversion strength (Figure 14):

Clinical assessment:
Symmetry of ankle joint strength can be assessed by utilizing the non-injured limb as a comparator.

Figure 14. A hand-held dynamometer is used to assess ankle joint isometric eversion strength.
Ankle joint inversion strength test

Recommended position for testing isometric ankle joint inversion strength (Figure 15):

Clinical assessment:
Symmetry of ankle joint strength can be assessed by utilizing the non-injured limb as a comparator.

Figure 15. A hand-held dynamometer is used to assess ankle joint isometric inversion strength.
Ankle joint dorsiflexion strength test

*Recommended position for testing isometric ankle joint dorsiflexion strength (Figure 16):*

*Clinical assessment:*
Symmetry of ankle joint strength can be assessed by utilizing the non-injured limb as a comparator.

![Image of ankle joint dorsiflexion strength test](https://mc.manuscriptcentral.com/bjsm)

*Figure 16. A hand-held dynamometer is used to assess ankle joint isometric dorsiflexion strength.*
Balance Error Scoring System

*Balance Error Scoring System test positions (Figure 17 – 22):*

- Double leg stance (firm surface)
- Tandem stance (firm surface)
- Single leg stance (firm surface)
- Double leg stance (foam surface)
- Tandem stance (foam surface)
- Single leg stance (foam surface)

Clinical interpretation: Each of the test positions requires the patient to maintain the specified stance position for 20 seconds. During the 20-second test, the clinician counts the number of deviations (errors) from the specified stance position.

<table>
<thead>
<tr>
<th>Deviations (errors)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Moving the hands off the hips</td>
</tr>
<tr>
<td>2 Opening the eyes</td>
</tr>
<tr>
<td>3 Step, stumble or fall</td>
</tr>
<tr>
<td>4 Abduction or flexion of the hip more than 30°</td>
</tr>
<tr>
<td>5 Lifting the forefoot or heel off the support surface</td>
</tr>
<tr>
<td>6 Remaining out of the specified stance position for &gt; 5 seconds</td>
</tr>
</tbody>
</table>

*The maximum total number of errors for any single stance position is 10*

*If a patient commits numerous deviations (errors) at the same time, only one deviation (error) is recorded*
Figure 17: Double leg stance (firm surface). The test is initiated and lasts for 20 seconds when the patient closes his/her eyes.
Figure 18: Tandem stance (firm surface). The test is initiated and lasts for 20 seconds when the patients closes his/her eyes.
Figure 19: Single leg stance (firm surface). The test is initiated and lasts for 20 seconds when the patient closes his/her eyes.
Figure 20: Double leg stance (foam surface). The test is initiated and lasts for 20 seconds when the patient closes his/her eyes.
Figure 21: Tandem stance (foam surface). The test is initiated and lasts for 20 seconds when the patient closes his/her eyes.
Figure 22: Single leg stance (foam surface). The test is initiated and lasts for 20 seconds when the patient closes his/her eyes.
Foot Lift Test

Foot Lift Test position (Figure 23):

Clinical assessment:
The patient maintains the specified stance position on one leg with the eyes closed for 30 seconds.

Clinical interpretation:
During the 30-second test, the clinician counts the number of times any part of the foot is lifted from the ground, and any touch downs with the other foot.
Figure 23: The test is initiated and lasts for 30 seconds when the patients closes his/her eyes.
**Star Excursion Balance Test**

*Star Excursion Balance Test positions (Figure 24 – 27):*

Start position
Anterior reach direction
Posterior-medial reach direction
Posterior-lateral reach direction

*Clinical interpretation:* The reach distance achieved is normalized relative to the patient’s test leg length (measured as the distance from the ipsilateral anterior superior iliac spine to the tip of the ipsilateral medial malleolus)

\[
\frac{\text{reach distance achieved (cm)}}{\text{leg length (cm)}} \times 100
\]
Figure 24. Start position.
Figure 25. Anterior reach direction.
Figure 27. Posterior-lateral reach direction.
# Tegner Activity Level Scale

Please indicate in the space below the **HIGHEST** level of activity that you participated in **BEFORE YOUR INJURY** and the highest level you are able to participate in **CURRENTLY**.

**BEFORE INJURY:** Level: _______

**CURRENTLY:** Level: _______

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Level 10</strong></td>
<td>Competitive sports: soccer, football, rugby (national elite)</td>
</tr>
<tr>
<td><strong>Level 9</strong></td>
<td>Competitive sports: soccer, football, rugby (lower divisions), ice hockey, wrestling, gymnastics, basketball</td>
</tr>
<tr>
<td><strong>Level 8</strong></td>
<td>Competitive sports: racquetball or bandy, squash or badminton, track and field athletics (jumping, etc.), down-hill skiing</td>
</tr>
</tbody>
</table>
| **Level 7** | Competitive sports: tennis, running, motorcars speedway, handball  
Recreational sports: soccer, football, rugby, bandy, ice hockey, basketball, squash, racquetball, running |
| **Level 6** | Recreational sports: tennis and badminton, handball, racquetball, down-hill skiing, jogging at least 5 times per week |
| **Level 5** | Work: heavy labor (construction, etc.)  
Competitive sports: cycling, cross-country skiing,  
Recreational sports: jogging on uneven ground at least twice weekly |
| **Level 4** | Work: moderately heavy labor (e.g. truck driving, etc.) |
| **Level 3** | Work: light labor (nursing, etc.) |
| **Level 2** | Work: light labor  
Walking on uneven ground possible, but impossible to back pack or hike |
| **Level 1** | Work: sedentary (secretarial, etc.) |
| **Level 0** | Sick leave or disability pension because of knee problems |
Foot and Ankle Ability Measure (FAAM)

Please answer every question with one response that most closely describes your condition within the past week. If the activity in question is limited by something other than your foot or ankle mark not applicable (N/A).

<table>
<thead>
<tr>
<th>Activity</th>
<th>No difficulty</th>
<th>Slight difficulty</th>
<th>Moderate difficulty</th>
<th>Extreme difficulty</th>
<th>Unable to do</th>
<th>N/A</th>
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</thead>
<tbody>
<tr>
<td>Standing</td>
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<tr>
<td>Walking on even ground</td>
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<tr>
<td>Walking on even ground without shoes</td>
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<tr>
<td>Walking up hills</td>
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<tr>
<td>Walking down hills</td>
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<tr>
<td>Going up stairs</td>
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<tr>
<td>Going down stairs</td>
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<tr>
<td>Walking on uneven ground</td>
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<tr>
<td>Stepping up and down curbs</td>
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<tr>
<td>Squatting</td>
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<tr>
<td>Coming up on your toes</td>
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<tr>
<td>Walking initially</td>
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<tr>
<td>Walking 5 minutes or less</td>
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<tr>
<td>Walking approximately 10 minutes</td>
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<tr>
<td>Walking 15 minutes or greater</td>
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</tbody>
</table>
Because of your **foot and ankle** how much difficulty do you have with:

<table>
<thead>
<tr>
<th>Activity</th>
<th>No difficulty at all</th>
<th>Slight difficulty</th>
<th>Moderate difficulty</th>
<th>Extreme difficulty</th>
<th>Unable to do</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Home Responsibilities</td>
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<tr>
<td>Activities of daily living</td>
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<tr>
<td>Personal care</td>
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<tr>
<td>Light to moderate work (standing, walking)</td>
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<td>Heavy work (push/pulling, climbing, carrying)</td>
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<tr>
<td>Recreational activities</td>
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</tbody>
</table>

How would you rate your current level of function during your usual activities of daily living from 0 to 100 with 100 being your level of function prior to your foot or ankle problem and 0 being the inability to perform any of your usual daily activities?

0 %