

Clinical practice guidelines for physical therapy in patients with acute ankle sprain

RA de Bie PT PhD,^I HJM Hendriks PT PhD,^{II} AF Lenssen PT MSc,^{III} SR van Moorsel PT,^{IV} KWF Opraus PT,^V WFA Remkes PT,^{VI} RAHM Swinkels PT MSc.^{VII}

Introduction

These guidelines embody the diagnostic and therapeutic processes, including secondary prevention, involved in the physical therapy of acute ankle sprain, which is defined as traumatic injury to the lateral capsular ligament of the ankle. In the second part of these guidelines, entitled “Review of the evidence”, the choices made in constructing the guidelines are justified. The abbreviations and key concepts used are explained in an attached list of abbreviations and glossary.

These guidelines, which are specifically aimed at physical therapists, can be seen as complementing interdisciplinary guidelines on the diagnosis and treatment of acute ankle sprain devised by a working group of Dutch medical specialists, primary care

physicians and physical therapists under the auspices of the (Dutch) Collaborating Center for Quality Assurance in Healthcare (CBO). The guidelines drawn up by the CBO, entitled “Consensus on acute ankle injury”, are, where relevant to physical therapy practice, in line with the guidelines described here, which have been produced by the Royal Dutch Society for Physical Therapy (KNGF).

A central stipulation of these guidelines is that examination and treatment should take place within six weeks of the injury occurring. Ideally, application of the approach described in these guidelines should be carried out in the acute phase, i.e., within five days of the injury. At the first consultation, the physical therapist should determine the patient's phase of recovery, which can be related to the different phases

Table 1. The different phases of ‘normal’ recovery from acute ankle injury and corresponding therapeutic phases. Transfer phase 1 is applicable when the desired load-bearing capacity is that required for the performance of normal daily activities and work, and transfer phase 2 is applicable when the desired load-bearing capacity is that for elite athletes.

Phase	Normal tissue recovery phase	Therapeutic phase
1	Inflammatory phase: injury occurred 0–3 days previously	Therapeutic phase 1
2	Proliferation phase: injury occurred 4–10 days previously	Therapeutic phase 2
3	Early remodeling phase: injury occurred 11–21 days previously	Therapeutic phase 3 (integration phase)
4	Late remodeling phase: injury occurred 3–6 weeks previously	Therapeutic phase 4 (Transfer phase 1)
5		Transfer phase 2

^I Department of Epidemiology, Maastricht University, Maastricht, the Netherlands.

^{II} Department of Research and Development, Dutch Institute of Allied Health Professions, Amersfoort, the Netherlands.

^{III} Department of Physiotherapy, University Hospital Maastricht, Maastricht, the Netherlands.

^{IV} Department of Physiotherapy, University Medical Center, Catholic University Nijmegen (KUN), Nijmegen, the Netherlands.

^V Primary healthcare center ‘de Akkers’, Spijkernisse, the Netherlands.

^{VI} Department of Physiotherapy, Hogeschool Arnhem en Nijmegen, Nijmegen, the Netherlands.

^{VII} Physical therapy and manual therapy practice ‘de Coevering’, Geldrop, the Netherlands.

in the natural course of recovery shown in Table 1 and to the duration of the complaint as measured from the time of occurrence of the trauma.

The objective of the diagnostic process is to assess the severity and nature of the health problem and to evaluate to what extent it can be influenced. The key issues are whether there is 'normal' recovery or a deviation from the norm (i.e., delayed recovery) and whether physical therapy is indicated. The central goals of the therapeutic process are to improve patients' functions and abilities and to increase their level of participation in normal life. The therapeutic process is designed to mirror the different phases of normal recovery.

In general, these guidelines are not suitable for use in the examination or treatment of patients with injuries older than six weeks. Moreover, these guidelines are designed for simple inversion injuries of the ankle that lead to lesions in the lateral capsular ligament. If the injury is more extensive than a simple lateral capsular ligament injury, more detailed diagnostic examination is indicated, if necessary in consultation with the referring physician. This may lead to use of a treatment strategy that is different from the one described in these guideline.

Epidemiological data

Conservative estimates indicate that the incidence of injuries to the capsular ligament of the ankle in the Netherlands is around 575,000 per year. Over 85% of all lesions are caused by inversion traumas affecting the anterior talofibular ligament. The (Dutch) Continuous Morbidity Register shows that 240,000 injuries of this kind are reported to primary care physicians each year, with approximately 60,000 of the patients affected being referred to physical therapists and approximately 9,500 to medical specialists. About 24,000 injuries a year are X-rayed.

Target group

These guidelines are intended for physical therapists working in intramural and extramural healthcare. Training in bandaging and taping is essential for

carrying out guideline recommendations correctly. The therapist is expected to have adequate knowledge of recovery, including its different phases, and of exercise therapy. Furthermore, he¹ is expected to be able to provide adequate support for the ankle injury by bandaging or taping it, or both, and to have experience with ankle braces.

Referral

Implementation of these guidelines requires that the patient with an acute ankle sprain has been referred by a primary care physician or medical specialist. The referral documentation should include medical data indicating an injury to the lateral capsular ligament of the ankle and detail the findings of any additional examinations carried out. The physical therapist should contact the referring physician if the referral documentation contains insufficient data.

Diagnosis

The objective of the diagnostic process is to assess, while taking into account medical data in the referral documentation, whether physical therapy can influence the causal and aggravating factors that led to the health problem reported by the patient and observed by the physical therapist. The information listed below is important in assessing the severity and prognosis of the injury to the capsular ligament of the ankle.

History taking

Causal factors:

- Was an inversion trauma involved?
- How did the trauma occur?
- Is it a recurrent injury? If so, how long ago did the injury first occur and how well did the patient recover?

Progress over time:

- When did the trauma occur?
- What actions has the patient taken (e.g., cooling, compression, elevation and rest)?
- Did the pain occur immediately after the trauma?
- How has the pain changed?

* The combinations 'he/she' and 'his/her' have been avoided in these guidelines to facilitate readability. The terms 'he' and 'his' should be understood to apply to both sexes.

- When did the swelling occur? Was it fast or slow?
- How has the swelling changed over time?
- How has local load-bearing capacity changed over time?

Current complaints:

- Does weight-bearing currently cause pain in the injured ankle?
- Is the weight-bearing function of the foot diminished at the moment?
- To what extent can the patient put weight on the joint during normal daily activities, at work, and while participating in sports?
- Is there any relevant additional pathology?

Examination

- Where is the pain located?
- Where is the swelling? What color is the skin?
- Is the swelling slight, moderate or severe at the moment?
- Are any postural abnormalities observable on examination of the lower leg?
- Are any postural abnormalities observable on comparing the lower leg with the foot and ankle of the unaffected leg?

Functional testing

- What is the extent of the foot's plantar and dorsal flexion when assessed by active movement tests?
- How much weight can the foot bear?
- Can the patient stand on one leg?
- How is the balance response compared with that of the unaffected side and how is it affected by walking?

Palpation and differential diagnosis

Palpation is important only when a differential diagnosis has to be made. Fractures may accompany acute ankle sprain. The working group recommends use of the Ottawa ankle rules to diagnose fractures in the acute phase, that is from immediately after the trauma to 4-5 days after injury. According to these rules, an X-ray of the ankle is indicated if the patient:

- is unable to put weight on the ankle (i.e. walk four 2 x 2 steps); or
- reports pain on palpation on the dorsal side of one or both malleoli.

Other examination findings that may point to a

fracture are:

- axial pressure pain at the front of the foot or heel;
- pressure pain along the fibula (i.e., a possible Maisonneuve fracture);
- pressure pain at the head of the fifth metatarsal bone (i.e., a possible avulsion fracture).

In most cases, small avulsion fractures will not affect the therapy selected. An ability to put weight on the foot indicates that a fracture is less likely and is a favorable sign in terms of the severity of the trauma and the success of recovery.

Muscle or tendon injuries might be indicated by the following finding:

- an inability to tense the muscle because of pain or because the muscle or tendon is ruptured.

Indications of more extensive injury are:

- hypermobility or hypomobility of the ankle; or
- pain on the medial side (i.e., 'kissing pain' or osteochondral injury).

When a fracture, muscle or tendon injury, or more extensive pathology is suspected, the patient should be sent back to the referring physician or the referring physician should be consulted. The physician can then perform or ask for a confirmatory diagnosis to determine the required treatment.

Points of reference

'Normal' recovery results in restored function after six to eight weeks, a return to sporting activities after eight to 12 weeks, and complete recovery. Walking is normally possible within one to two weeks. If this is not the case, retarding factors should be sought. In inversion traumata, one should consider such factors as: relevant associated pathology that impedes normal recovery; an out-of-control inflammatory response; unexplained pain the patient is unable to control; insufficient modification of posture and movement behavior (e.g., a relative or absolute overload); or recurrent or pre-existing ankle instability.

Function score

Determining a function score enables the physical therapist to make a prognosis about the expected time for recovery from the injury (see Table 2). The

Pain	
- none	35
- during or after sports	30
- while running on a non-level surface	25
- while running on a level surface	20
- while walking on a non-level surface	15
- while walking on a level surface	10
- when putting weight on the injured foot	5
- constant pain at rest	0
Dynamic instability	
- never	25
- occasionally	20
- frequently during sports	15
- occasionally during normal daily activities	10
- frequently during normal daily activities	5
- at each step	0
Weight-bearing capacity	
- can hop on the injured leg	20
- can stand on the toes of the injured leg	15
- can stand on the injured leg	10
- can stand on both legs	5
- cannot bear any weight	0
Swelling	
- no swelling	10
- slight swelling	6
- mild swelling	3
- severe swelling	0
Gait	
- can run	10
- can walk properly	6
- walks with a minor limp	3
- walks with a severe limp	0
Totaal	—

function score can also be used to obtain a reference value against which the patient's rate of healing during recovery can be judged (see Figure 1 in the second part, entitled "Review of evidence", for reference values for athletes and non-athletes). If the patient has a function score greater than 40 points at the first examination, he can be expected to be able

to carry out everyday activities within 14 days. These patients, who have slight injuries, will be able to walk reasonably well very soon. They usually have little pain during walking and slight swelling. These slight injuries do not usually require physical therapy as long as recovery proceeds normally. More serious injuries, corresponding to function scores less than or equal to 40, should be monitored and considered for treatment.

Table 2. Scoring system for obtaining function scores to assess the severity of acute ankle sprain. A function score greater than 40 points indicates a slight injury that does not usually require therapy. If appropriate, the injury could be taped and an appointment made for a check-up. The treatment given depends on the patient's individual goals. If the function score is $\leq$ 40 points and recovery is progressing normally, once-a-week appointments should be made to change the tape, assess recovery, and administer treatment in accordance with the guidelines. If the function score is $\leq$ 40 points and recovery is progressing abnormally, retarding factors should be sought to determine whether they can be influenced by physical therapy. The frequency of treatment should be changed, if necessary.

Analysis and treatment plan

The central goal of the diagnostic process is to ascertain whether referral for physical therapy is appropriate. During analysis, the indications for physical therapy and the prognosis for recovery of function are made explicit. The following questions have to be answered:

- What is the recovery phase of the affected tissues and organs at examination?
- Do the physical therapy findings reflect a normal course of recovery (see Table 3)?
- Does the duration of symptoms (i.e., the period of time since the trauma) reflect the indicated phase of normal recovery?
- Has the course of recovery from the ankle injury been normal up to the time of examination or has recovery been abnormal (i.e., delayed recovery)?
- What is the prognosis for recovery? (The function score can be used to predict the expected period of time for recovery, with or without physical therapy treatment or guidance.)

Table 3. Table for evaluating to what extent physical therapy findings on the actual phase of recovery (i.e., relative time) coincide with the expected normal phase of recovery (i.e., absolute time). CI = confidence interval.

Phase	Phase in normal recovery (Absolute time)	Actual phase of recovery (Relative time)	Is the normal recovery phase the same as the actual phase?	Expected function score Mean (95% CI)
1.	Inflammatory phase: 0–3 days	Inflammatory phase – duration of symptoms: ____	yes/no	19 (17–21)
2.	Proliferation phase: 4–10 days	Proliferation phase – duration of symptoms: ____	yes/no	35 (32–38)
3.	Early remodeling phase: 11–21 days	Early remodeling phase – duration of symptoms: ____	yes/no	57 (54–60)
4.	Late remodeling phase; 3–6 weeks	Late remodeling phase – duration of symptoms: ____	yes/no	74 (70–78)

- If recovery is found to be abnormal, answers to the following questions are important:
 - Are local conditions appropriate for recovery? Can any local factors that are retarding recovery be influenced by physical therapy?
 - Are general conditions appropriate for recovery? Can any general factors that are retarding recovery be influenced by physical therapy?

Conclusion

The physical therapist has to determine (a) whether referral for physical therapy is appropriate and (b) whether the patient can be treated according to these guideline.

If the therapist has any doubts about the severity or nature of the injury, he should consult the referring physician or refer the patient back to the referring physician for further diagnosis and to obtain a recommendation for treatment. A function score of more than 40 points at the first visit (i.e., 1–5 days after the trauma) generally indicates that the patient will be able to return to his normal daily activities within 14 days. These patients should not need treatment after consulting the physical therapist, though perhaps a check-up may be required. Depending on the goals of the referring physician and of the patient himself, the approach chosen may be modified.

Once the patient's situation has been determined, a treatment plan should be formulated in consultation with the patient and individual treatment goals set. The basic elements of the therapeutic approach are as follows: treatment strategy; interventions; prognosis; and an (interim) evaluation of the result of treatment.

Therapy Principles

The goal of physical therapy is to optimize the patient's structures, functions, abilities and level of participation. The extent to which this goal can be achieved depends, among other things, on the factors that are retarding normal recovery. Under normal conditions, four phases of tissue recovery can be distinguished: the inflammatory phase, the proliferation phase, the early remodeling phase, and the late remodeling phase. In the guidelines, the patient's treatment phases are linked to the four recovery phases (see Table 1).

If the patient has been referred between zero and five days after injury, the frequency of treatment can be established using the function (or prognostic) score as described given above (see Table 2):

- if the function score is 40 points or less and there is abnormal recovery, the frequency of treatment should be adjusted, perhaps increased;
- if the function score is more than 40 points, the

corresponding slight injury does not usually require physical therapy. If appropriate, the ankle should be taped and an appointment made for a check-up. The treatment given depends on the patient's individual goals;

- if the patient's desired load-bearing capacity is not appropriate for the load expected from work, hobbies or sporting activities, the physical therapist will devise a tailor-made program of treatment and training that is specially designed to achieve the required level of activity, including that needed for specific sporting activities. This type of guidance and treatment requires special expertise.

As detailed below, the therapeutic process is designed in accordance with the different phases of normal recovery (see Tables 1 and 3).

Phase 1 of therapy – inflammatory phase, 0–3 days after the trauma

Physical therapy findings during normal recovery:

- pain at rest;
- swelling or bruising present; and
- the patient cannot put all his weight on the affected foot.

If findings are in line with normal recovery, the treatment outlined below should be given.

If findings are not in line with normal recovery, a search should be made for the possible causes of any deviation from normal recovery, such as unexplained pain, a severe inflammatory response, or complete inability to stand on the affected leg. The factors retarding normal recovery should be determined and it should be ascertained whether these factors can be influenced by physical therapy and whether the patient can be treated in accordance with the guidelines. If the therapist has any doubts about the severity or nature of the injury, he should contact the referring physician or refer the patient back.

Treatment goals

The treatment goals are to reduce pain and swelling, to stimulate the circulation, and to enable partial loading.

Physical therapy interventions include giving

information and advice, providing exercises, and guiding recovery.

Giving information

The physical therapist should give information about the nature and severity of capsular ligament injury and what can be expected in normal recovery.

Giving advice

- Generally, the patient should be advised to rest and elevate the foot. The patient may apply a cold compress to the injury for 15–20 minutes, one to three times a day, and the injury may be bandaged, if appropriate;
- The patient should be advised not to place weight on the foot while walking if it causes too much pain and to use crutches, if appropriate;
- At work, if the patient's job requires him to put his weight on the affected ankle or foot, he should apply for sick leave or consult his employer about ways of avoiding the activities concerned. For sedentary occupations, the patient may return to work but may need to keep the foot elevated;
- Sporting activity should be avoided in anticipation of further recovery.

Providing exercise

The foot and toes should be moved as much as possible within the pain threshold in order to stimulate the circulation. No loads should be placed on the foot.

Details of check-ups and further treatment are given in the description of therapeutic phase 2.

Phase 2 of therapy – proliferation phase, 4–10 days after the trauma

Physical therapy findings during normal recovery:

- the patient can actively move his foot to the zero position, at a right angle to the lower leg;
- swelling and bruising are reduced;
- the patient can support himself on the affected foot but cannot yet completely move the foot through its full range of motion from heel-strike to toe-off; and
- the patient may be afraid to move (with or without taping).

If findings are in line with normal recovery, the

treatment outlined below should be given.

If findings are not in line with normal recovery, refer to therapeutic phase 1.

Treatment goals

The treatment goals are to counteract activity limitations and functional impairments, and to increase load-bearing capacity.

Physical therapy interventions

Apply ankle tape or a brace, give advice, provide exercise, and guide recovery.

Use of tape or a brace

The injury should be taped or a brace used once swelling has decreased sufficiently. It is advisable to use therapeutic bandages or tape. Use of a therapeutic brace provides another way of achieving the same goal.

Giving advice

- The patient should be advised to walk if it does not cause too much pain. Crutches should be used, if appropriate, with the aim of achieving a symmetrical load and of actively moving the foot through its full range of motion from heel-strike to toe-off without increasing inflammatory symptoms such as pain and swelling. A symmetrical gait should be attainable after 4–10 days.
- At work, if the patient's job requires him to place his weight on the affected foot, he should return to work only when he is capable of moving the foot through its full range of motion from heel-strike to toe-off or after consulting his employer on ways of avoiding such actions. For sedentary occupations, the patient can return to work immediately but may need to elevate the foot.

Providing exercise

Exercises should aim to improve mobility, active stability, coordination and walking.

In this phase, it is important that weight be put on the injured ankle in a functional way during normal daily activities.

The patient should undergo a check-up and receive

further treatment after about one week (see therapeutic phase 3). It is recommended that the tape is changed after one week.

Phase 3 of therapy (integration phase) – early remodeling phase, 11–21 days after the trauma

Physical therapy findings during normal recovery:

- swelling is reduced or almost undetectable;
- bruising is still present;
- the patient can move the foot normally through its full range of motion from heel-strike to toe-off when walking and can bear weight on the foot while standing and walking; and
- there is still some pain and the patient is still cautious while performing normal daily activities.

If findings are in line with normal recovery, the treatment outlined below should be given.

If findings are not in line with normal recovery, refer to therapeutic phase 1.

Treatment goals

The treatment goals are to improve muscle strength, active (functional) stability, mobility, and movement while walking, running and using stairs.

Physical therapy interventions

Give information, apply tape or a brace if necessary, and provide exercise.

Giving information

- give information about how recovery normally progresses;
- give information about protective measures that could be taken when exposing the ankle to severe stress, for example, on returning to high-risk work or in participating in sporting activities. The injured ankle can be taped or a brace can be worn for support. These protective measures can be used until the patient can adequately perform static and dynamic balance and coordination exercises aimed at promoting functional stability;
- the footwear, for sporting or normal use, worn by the patient can also be examined to determine whether it is suitable for the sport or surface in question. Footwear may have to be adapted.

Use of tape or a brace

The patient should be advised to use tape or a brace during sporting activities or when undertaking any other strenuous physical activity.

Providing exercise

- to improve balance, muscle strength, mobility and movement; and
- to train dynamic stability. As soon as the ankle can bear sufficient weight, active load-bearing exercises should be started with the specific aim of improving balance and coordination. The degree of difficulty and the loading should be gradually increased in line with the patient's functional stability, provided that no swelling results.

When considering the nature and design of the exercises, attention should be paid to structuring them so that there is a progression, for instance, from static to dynamic exercise, from partial load to full load, and from simple exercises to functional exercises involving dual tasks and a variety of surfaces. Giving instruction on exercising at home is an essential part of therapy. The goal of this phase is to achieve a symmetrical gait.

The patient should undergo a check-up and receive further treatment after about one week.

Phase 4 of therapy (transfer phase 1) – late remodeling phase, 3–6 weeks after the trauma

Physical therapy findings during normal recovery:

- swelling is no longer present;
- bruising is no longer present;
- the patient can bear his full weight on the foot and can move it normally through its full range of motion from heel-strike to toe-off while walking; and
- the patient still experiences some pain or is still cautious while performing normal daily or sporting activities.

If findings are in line with normal recovery, no further guidance is required after the physical therapy interventions described below unless the ankle will be exposed to severe stress because the patient is an elite athlete or because his job makes a high demand on the ankle. If either of these is the case, the exercise

and training program should be expanded.

If findings are not in line with normal recovery, refer to therapeutic phase 1.

Treatment goals

The treatment goals are to increase the regional load-bearing capabilities needed for walking, using stairs, working, carrying out household chores, and participating in sporting activities.

Physical therapy interventions

Give information and advice, and provide exercise.

Giving information and advice

See section on giving information in therapeutic phase 3.

Providing exercise

- the exercise program should be adjusted to incorporate normal loads. The priority should be training coordination while practicing activities such as hopping and jumping.

In this context, normal load is the load that was normally placed on the ankle before the trauma, which may include loads associated with sporting activities. It is very important that the load is increased progressively. When considering the nature and design of exercises, attention should be paid to structuring them so that there is a progression, for instance, from static to dynamic exercises and from simple exercises to functional exercises involving dual tasks and a variety of surfaces. It is advisable that the patient continue with a varied range of exercises aimed at improving coordination until the final goals have been achieved. Giving instruction on performing exercises is an essential part of therapy. Patients who place high demands on their ankles, such as elite athletes, should continue to receive treatment until the desired load-bearing capacity has been reached. This phase of treatment corresponds to therapeutic phase 5, or transfer phase 2, in Table 1.

If the patient's desired load-bearing capacity is not appropriate for the load expected from work, hobbies or sporting activities, the physical therapist will devise a tailor-made program of treatment and

training that is specially designed to achieve the required level of activity, including that needed for specific sporting activities. This type of guidance and treatment requires special expertise.

Conclusion and reporting

At the conclusion of treatment, reports should be made in accordance with guidelines issued by the Royal Dutch Society for Physical Therapy (KNGF) entitled “Communicating with and reporting back to general practitioners” and “Physiotherapeutic documentation and reporting”.

Review of the evidence

Introduction

The guidelines on acute ankle sprain produced by the Royal Dutch Society for Physical Therapy (KNGF) cover the physical therapy of patients with injury to the lateral joint capsule and lateral ligaments of the ankle. The guidelines include a methodical description of diagnostic and therapeutic processes and focus on secondary prevention. At the time of writing, two other sets of clinical guidelines concerning the diagnosis and treatment of lateral ankle injuries are in use in the Netherlands. These are the (Dutch) Collaborating Center for Quality Assurance in Healthcare (CBO) consensus document entitled “The diagnosis and treatment of lateral ankle injuries”¹ and the Dutch College of General Practitioners (NHG) standard recommendations on “Ankle distortion”.² The CBO consensus guidelines were prepared by a group comprising orthopedic surgeons, surgeons, radiologists, sport physicians, primary care physicians, physical therapists and epidemiologists. All three sets of guidelines have taken the others into account and are, in the main, consistent with each other.

Definition

KNGF guidelines are defined as “systematic developments from a core guide formulated by professionals that focuses on the context in which the methodical physical therapy of certain health problems is applied and that takes into account the organization of the profession”.³⁻⁶

Goals of the KNGF guidelines on acute ankle sprain

The goals of the guidelines are to describe the optimal, in terms of effectiveness and efficiency, physical therapy for patients with acute ankle sprain. Application of the guidelines should lead to full recovery and to the prevention of residual complaints or repeated injuries. Guideline recommendations are based on current scientific research.

The results of research show that, in practice, therapeutic goals, interventions and the application

of physical therapy vary widely.⁷ In addition to the above-mentioned guideline goals, the KNGF guidelines are explicitly designed:

- to adapt the care provided to take into account current scientific research and to improve the quality and uniformity of care;
- to provide some insight into the tasks and responsibilities of the physical therapist and to stimulate cooperation with other professions; and
- to aid the decision-making process.

Clinical context

The group that formulated these guidelines set out to answer the following questions:

- How big a problem is acute injury of the lateral capsular ligament of the ankle?
- Which parts of the physical therapy diagnostic process are valid, reliable and useful in daily practice?
- Which forms of treatment and approaches to prevention produce significant results?

The monodisciplinary working group

In September 1996, a working group of professionals from a single discipline was formed to find answers to these clinical questions. In forming the working group, an attempt was made to achieve a balance between professionals with experience in the area of concern and those with an academic background. All members of the working group stated that they had no conflicts of interest in participating in the development of the guidelines. Guideline development took place from September 1996 through February 1998.

The guidelines were developed in accordance with concepts outlined in a KNGF document entitled “A method for the development and implementation of clinical guidelines”.⁴ This document includes practical recommendations on the strategies that should be used for collecting scientific literature, including the appropriate search terms, the sources to be consulted, and the period of time during which appropriate literature has accumulated. The document also details the criteria to be used in

selecting suitable literature and describes how to derive guideline recommendations. For these guidelines, where no scientific evidence was found, guideline recommendations were based on the consensus reached within the working group. Once the monodisciplinary guidelines were completed, they were sent for evaluation by external professionals or members of professional organizations, or both, who formed a secondary working group. The reason for this step in the guideline development process is to ensure that there is a general consensus with other professional groups or organizations and that any other available monodisciplinary and multidisciplinary guidelines are taken into account.

The members of the working group have individually selected and graded the proceedings with respect to the quality of the scientific evidence. Even though the scientific evidence was collected by individuals or by smaller subgroups, the results of the process were presented to and discussed by the whole working group. Thereafter, a final summary of the scientific evidence, which included details of the amount of evidence available, was made. In addition to being based on scientific evidence, other important factors were taken into account in making recommendations, such as: the achievement of a general consensus, treatment cost-effectiveness, the availability of resources, the availability of the necessary expertise and educational facilities, organizational matters, and the desire for consistency with other monodisciplinary and multidisciplinary guidelines. Consistency was achieved by publishing the KNGF guidelines only after they had been brought into agreement with the CBO consensus document "The diagnosis and treatment of lateral ankle injuries".(1) Furthermore, the KNGF guidelines will be included in an updated version of the NHG standard recommendations on "Ankle distortion".(2) Normally, before they are published and distributed, guidelines are reviewed and validated by the target group that will use the guidelines. The KNGF guidelines on acute ankle sprain were presented three times to a randomly selected group of 50 physical therapists working in different health sectors: the first time, for comments on the diagnostic process; the second time, for comments on the therapeutic

process; and, the third time, for comments on the guidelines as a whole.(8) The physical therapists' comments and criticisms were recorded and discussed by the working group. If possible or desirable, they were included in the final version of the guidelines. The final recommendations, then, encapsulate the combined results of a review of the available evidence, which takes the other above-mentioned important factors into account, and an evaluation of the guidelines by the physical therapists who will use them.

Composition and implementation of the guidelines

The guidelines comprise three parts: the practice guidelines themselves, a schematic summary of the most important points in the guidelines, and a review of the evidence. Each part can be read individually. In addition to the guidelines, a professional development module has also been developed and published to promote implementation in daily practice.(9) The guidelines should be implemented in accordance with the standard method of implementation, which has been described elsewhere.(3-5,10)

Literature review

The publications reviewed were collected using the following databases: Index Medicus and Excerpta Medica, on CD-ROM; the Cochrane Library rehabilitation and therapy field, accessed at the University of Maastricht; and the database of the documentation center of the Dutch Institute of Allied Health Professions (NPi). The following keywords were used in the search: ankle, treatment, distortion, prognosis, diagnosis, and prevention. For interventions, searching was carried out using the following keywords: exercise therapy, movement therapy, bandaging, laser therapy, cryotherapy, electrotherapy, taping, ultrasound, and short wave therapy. Furthermore, secondary references derived from the studies found were also traced. This process led to the identification of a total of 151 studies, which were selected on the basis of the quality criteria described by Sackett et al.(6) After selection, 60 randomized clinical trials were left.

At the same time, a working group, which included representatives of all the relevant scientific

associations² and which worked under the auspices of the CBO, was developing multidisciplinary guidelines. The principles formulated in and scientific evidence used in these CBO guidelines are consistent with those of the KNGF guidelines on acute ankle sprain, insofar as they apply to physical therapy.

Epidemiological data

Figures produced by Schmikli and Backx¹¹ show that about half of all ankle injuries occur during sporting activities and half while carrying out household tasks or working. Conservative estimates indicate that the incidence of injuries to the capsular ligament of the ankle in the Netherlands is around 575,000 per year. Over 85% of all lesions are caused by inversion traumas affecting the anterior talofibular ligament.^{12–14} The (Dutch) Continuous Morbidity Register shows that 240,000 injuries of this kind are reported to primary care physicians each year, with approximately 60,000 of these patients being referred to physical therapists and approximately 9,500 to medical specialists. About 24,000 injuries a year are X-rayed.¹⁵

Apart from the medical costs resulting from these 240,000 ankle injuries per year, there are also considerable costs associated with sick leave and temporary or permanent incapacity for work.^{16,17} Persons suffering from capsular ligament ankle injuries resulting from sporting activities are absent from work or school for an average of 7.3 days. Ankle injuries account for 10–15% of total absenteeism from work.

The prevalence of chronic complaints following inversion injury of the ankle (i.e., persistent functional instability of the ankle) varies widely. There are reports that the rate is 10–20%,^{18,19} 30–40%^{14,20–22} and even over 50%.²³ Each study appears to use a different definition of functional instability and a different time-scale, either of which may be partly responsible for the reported differences.

When the results of treatment are evaluated, there

appears to be no difference between patients with single capsular injuries and those with multiple capsular injuries.¹⁴ The degree of functional recovery after one year is the same for both partial and total capsular injuries.²⁴ However, here too, it is important to be aware of differences in the definitions of capsular injury and functional recovery.

Diagnosis

The starting point for the preparation of these guidelines was that an acute traumatic injury to the lateral capsular ligament of the ankle had occurred. This type of injury is defined as a trauma that is immediately preceded by a moment of force that causes an inversion and that affects the lateral capsular ligament of the ankle (i.e., the anterior talofibular ligament, the anterior calcaneofibular ligament and the posterior talofibular ligament). Normally, the patient should be seen within a few days after the trauma. These guidelines acknowledge that patients may first be seen up to and including six weeks after the trauma. The ideal conditions for using these guidelines are when the patient is referred in the acute phase, 0–5 days after the injury. Injuries of the medial and more distal ligaments are not covered by these guidelines, neither is the usual classification of injury severity (i.e., classes 1, 2 and 3[3]2). The scientific literature reports no correlation between the severity of injury, judged on the basis of the above classification, and the likelihood of recovery, nor between the severity of injury and clinical findings.²⁴

The ability to put weight on the foot after the trauma is a positive sign because it clearly indicates that a fracture is unlikely to have occurred. The ability to bear the full body weight on the foot while walking a few days after the trauma indicates a good prognosis. These patients will almost certainly be able to function normally after 14 days. The prevalence of ankle fractures has been reported to range from 7% to 16%, depending on how patients are selected. A fracture that has not been treated properly can give rise to abnormalities in the ankle and thus to arthrosis. The working group recommends use of the

1 Dutch College of General Practitioners, (Dutch) Association for Sports Medicine, Royal Dutch Society for Physical Therapy, Dutch Association of Surgeons, Dutch Orthopedic Association, Dutch Association for Radiotherapy, Epidemiology Society.

Ottawa ankle rules during the acute phase, from immediately after the trauma to 4–5 days later.^{25–28} According to these rules, an X-ray of the ankle is only indicated if the patient is unable to put weight on the foot (i.e., unable to walk four 2 x 2 steps) or reports pain on palpation in one or both malleoli. Research has shown that selection using these rules leads to a 44% reduction in the number of X-rays taken but that all fractures are detected.^{25–28}

In themselves, pain and swelling reveal little about the severity of the ankle ligament injury. However, pain and swelling combined with a decreased ability to bear weight on the affected foot does seem to be important for prognosis.²⁹

Stress tests to assess the severity of the injury are not recommended. The validity and reliability of these tests leave something to be desired, particularly when they are performed without the use of a local anaesthetic.^{14,30} Passive tests to localize pain are not recommended because local treatment of pain points is not carried out under these guidelines and because no arguments in favor of such an approach have been presented in the literature.

There is no consensus in the literature on the benefits of conducting talar tilt tests and drawer tests. The prognostic value of these tests in predicting recovery from injury is limited and results do not influence the treatment policy being pursued. Moreover, the correlation between a positive talar tilt test and functional instability is only moderate.^{31–33} Consequently, these tests are not referred to in the guidelines. It is true that a drawer test, carried out in combination with other tests, can provide reliable confirmation of the existence of a rupture if it is performed four to five days after the trauma.^{14,34} However, again this would not affect the approach being pursued by the physical therapist.

Arthrography of the anterior and posterior talofibular ligament and tenography of the calcaneofibular ligament are the most reliable diagnostic methods for

detecting ankle ligament injury. However, the predictive value of these tests is limited.³⁵

Function score

When a patient with traumatic injury to the lateral capsular ligament of the ankle is referred within five days of the trauma, the physical therapist can use a function score to distinguish a mild injury from a more severe injury. A score of more than 40 points at the first visit means that the patient can be expected to be able to carry out everyday activities within 14 days. These patients with slight injuries will be able to walk reasonably well very soon. They usually experience slight swelling and have some pain on walking. These slight injuries do not usually require any physical therapy. However, treatment may be needed if the patient's ankle was already unstable (i.e., if there is a recurrent injury), provided that the referring physician gives consent. More serious injuries, corresponding to function scores of 40 or less, must be treated. Use of the function score is valid and reliable if the injury is seen within 5 days after initial trauma, confirmed and interpreted in the above described manner.²⁹

The function score can also be used to obtain a reference value against which the patient's progress during recovery can be judged. The function score obtained during recovery should be compared with values given by reference tables (see Figure 1). Note that it is important to distinguish between individuals who take part in sports and those who do not.

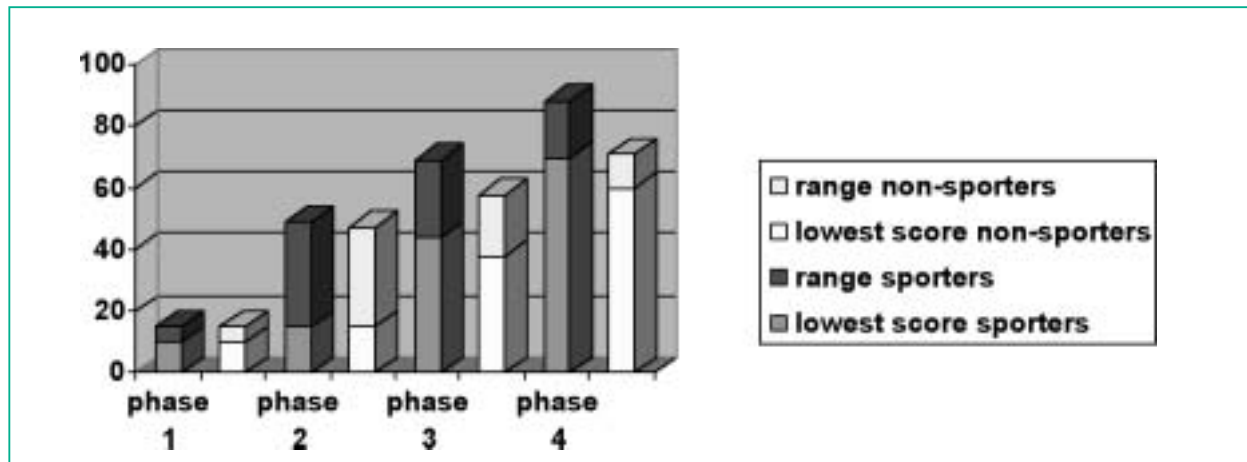
In order to obtain reliable function scores, the way in which different items in the scoring system are used must be clearly explained. See Table 4.

Therapy

The different treatment phases described in the guidelines are based on the, partly overlapping, phases of normal recovery: the inflammatory phase (0–3 days), which is characterized by the primary

2 Class 1: ankle stretched, with little pain or swelling, and no functional instability; class 2: a 'partial tear', with pain, swelling, and an inability to stand on the foot at present; class 3: a 'complete tear', with pain at rest, swelling, and an inability to stand on the foot.

Figure 1: Reference values for function scores at different stages in the recovery process from acute ankle injury for individuals who take part in sports (S) and for those who do not (NS).²⁹



reaction to tissue damage, with symptoms such as redness, swelling, elevated temperature and pain; the proliferation phase (4–10 days), in which new connective tissue is formed; the early remodeling phase (10–21 days); and the late remodeling phase (after 3–6 weeks). During both of the last two phases, connective tissue strengthens as it is exposed to an increasing level of stress.^{36–38}

A number of benefits result from the physical therapist relating data from history-taking and the physical therapy examination to the expected phase of physiological recovery. Knowing the course being followed by recovery, the physical therapist can determine: (i) whether recovery is normal or abnormal, including how much recovery deviates from the norm, which factors are retarding recovery, and whether these factors can be influenced by physical therapy; and (ii) whether or not physical therapy can be carried out in accordance with the guidelines and, if not, why not. The physical therapist must always ascertain whether or not the conditions needed for a normal recovery are present. This means that the physical therapist must know what the appropriate general and local conditions for recovery are for the patient concerned. For normal recovery, it is essential that:

- there is sufficient local adaptive capacity (i.e., tissue growth and recovery can occur);
- local conditions for recovery are present:
 - is there any dislocation?
 - is there any mechanical obstruction to the

circulation?

c. general conditions for recovery are present:

- are there any other medical conditions that may interfere with recovery?
- are there any subjective factors (e.g., complaining behavior or fear of movement) that do not correspond to the severity of the injury?
- has the patient adjusted his behavior sufficiently, in terms of posture and movement?

In general, normal recovery can take place if the above conditions have been met. During normal recovery, the physical therapist's functions are, among other things, to give the patient some insight into the process of normal recovery, to monitor increases in loading, and to provide exercise therapy.

If the conditions for normal recovery have not been met, the physical therapist should identify the factors that are causing abnormal recovery and determine whether these factors can be influenced. In addition, he must decide whether he is able to treat the patient in a different way from that recommended in the guidelines.

Inflammatory phase: 0–3 days after the trauma

Generally, cryotherapy has a better effect on swelling during the acute phase than contrast baths or the application of heat.^{39,40} Comparative research has been conducted into the effectiveness of cryotherapy,

Table 4. Explicit descriptions of how different items in the scoring system should be used to derive a function core. For interpretation see also table 2.

Pain

If pain is not constant but the patient cannot put weight on the affected foot, assign 5 points.

If the patient experiences no pain when walking on an even surface but does not yet dare to walk on uneven surface, assign 15 points.

If the patient experiences no pain when walking but does not yet dare to jog, assign 20 points.

If the patient experiences no pain when jogging on an even surface but does not yet jog on uneven surfaces, assign 25 points.

If the patient experiences no pain when jogging on an uneven surface but does not yet participate in sport at a high level, assign 30 points.

Dynamic instability

If the patient is stable when walking but does not yet dare to jog, assign 15 points.

A frequently recurring inversion trauma is defined as one that occurs every day.

Weight-bearing capacity

Ask the patient to carry out the relevant movement when assessing weight-bearing capacity.

Swelling

Swelling is assessed using the following criteria:

- slight swelling is a barely perceptible difference between the left and right ankles;
- moderate swelling is a clear difference between the left and right ankles, though the lateral malleolus can still be discerned;
- severe swelling is a very clear difference between the left and right ankles, with the area around the lateral malleolus completely swollen such that the lateral malleolus cannot be discerned.

Gait

A severe limp is when the patient is not able to move his foot actively through its full range of motion, i.e., he does not lift the heel of the affected leg when starting to take a step.

A slight limp is when the patient is able to extend the foot slightly but less than normal.

Walking speed should be kept within 110–120 steps per minute.

applying heat, and the use of contrast baths in treating swelling in class 1 and class 2 ankle sprains.³⁹ Treatment was administered once a day on the third, fourth and fifth days after the trauma. Cryotherapy was found to reduce swelling to the greatest extent. Both theoretical and scientific arguments provide some justification for the use of ice, heat and contrast baths.

Cold reduces the inflammatory response, bruising and swelling.^{41,42} Heat, on the other hand, increases blood flow to the treated area, which stimulates the absorption of intracellular fluids.⁴² The reasoning

behind the use of contrast baths is that alternating periods of vasoconstriction and vasodilatation boost, by means of a pump mechanism, venous and lymphatic transport systems, which should lead to a reduction in swelling.^{42–44} There is no consensus in the literature on which treatment is best during the acute phase (0–5 days). However, more scientific evidence supports the application of cold than the application of heat.^{45–47} Research conducted by Wallace et al.⁴⁷ indicates that the application of heat may even delay recovery. Existing research findings do provide sufficient evidence for recommending the application of cold. Theoretical considerations

suggest that the use of ice is only important in reducing hemorrhaging and suppressing pain in the acute phase.

The effectiveness of compression on swelling is not clear. The results of one study based on a randomized prospective trial indicate that compression has absolutely no effect on the amount of swelling, whereas elevation does.⁴⁸ On the other hand, other studies indicate that local compression of the lateral malleolus diminishes recovery time, in functional terms, by 25% compared to non-local compression.^{45,49–53} Consequently, the most appropriate treatment during the acute inflammatory phase includes rest, elevation, compression and the use of ice.

The effectiveness of physical therapy, in a narrow sense, has barely been investigated. One study looked at the effect of ultrasound therapy on recovery from ankle ligament injuries.⁵⁴ Ultrasound was not shown to have a beneficial effect. Neither did the use of diadynamic currents⁵⁵ or laser treatment⁵⁶ appear to have a positive effect on ankle ligament injuries. Short wave therapy is the most widely investigated treatment. However, apart from a study conducted by Wilson⁵⁷, no research demonstrated a positive effect on load-bearing capacity or pain. Moreover, Barker et al.⁵⁸ and Micholovitz et al.⁵⁹ observed no difference between groups receiving short wave therapy and control groups. Pasila et al.⁶⁰ found a small but significant difference in favor of short wave therapy with regard to load-bearing capacity, mobility, strength and amount of swelling. Pennington et al.⁶¹ found that short wave therapy had an effect on swelling and pain but not on load-bearing capacity or mobility. Furthermore, they found no correlation between measures of swelling and pain. The working group concluded, therefore, that there is insufficient scientific or clinical evidence to support the use of physical therapy, in a narrow sense, in patients with lateral ankle ligament lesions.

Proliferation and remodeling phases: more than three days after the trauma

One of the reasons for the continuing controversy about the best treatment of lateral ankle ligament injuries is that there is no consistent definition of the

term instability. In the literature, instability is often defined in bio-mechanical terms.^{62,63} The question is whether the definition of mechanical instability is synonymous with that of clinical instability.^{64,65} Against this background, Karlsson and Lansinger¹⁹ made, within the scope of ankle instability, a distinction between mechanical instability, which is described as instability determined from objective measurements obtained from, for example, stress X-ray examination or arthrograms, and functional instability, which is described as subjective reports of symptoms such as “the ankle repeatedly gives way”.

Functional instability is a complex subjective complaint that depends on mechanical as well as neuromuscular factors.^{66–68} Using a Cybex-II dynamometer, Tropp et al.⁶⁹ found a correlation between functional instability and isometric muscular weakness. They also demonstrated a correlation between functional instability and impaired postural control, which probably indicates that the underlying defect is muscular insufficiency stemming from a proprioceptive disorder. Functional instability is found after acute ligament rupture in about 40% of patients.²⁰ It has also been shown that the response time of the peroneus muscles is significantly lower in mechanically unstable ankles than in stable ankles.⁶⁶ None of these studies found a strong relationship between functional instability and mechanical instability. Data reported in the literature provide good grounds for believing that proprioceptive disorders play an essential role in the persistence of functional instability as well as in recovery from it.^{20,70–78} Therefore, it is important that proprioceptive disorders are taken into account in devising treatment guidelines and in carrying out physical therapy.

Van der Ent⁷⁹ gives three reasons for the lack of consensus on which of the following treatments is preferable: immobilization using a plaster cast, functional immobilization using tape, and primary surgical intervention.

1. In the past, these three treatment methods have been used together and in combination. Therefore, although a large amount of information on the results of treatment was published within a relatively short time, it could not be used to derive guidelines for treatment.
2. Different therapists tend to prefer using diagnostic and therapeutic methods that lie within the options offered by their own specialty.
3. Even after extensive examination of the literature, it is often not possible to arrive at any meaningful comparison of the results of treatment – patient groups may not be comparable or may be poorly defined, there may be differences in the diagnosis given and in interpreting diagnoses, and there may be differences in treatment protocols.

Having studied the literature, Van der Ent came to the following conclusions:

- Immobilization using a plaster cast produces worse results than primary surgery or taping in patients who were monitored for up to one year (the outcome measures were ability to return to a selected sporting activity and the extent of residual complaints).
- Functional treatment by taping, compared to surgery, leads to faster recovery and reduces the period of disability in patients who were monitored both six weeks and one year later.
- Conservative treatment does not enable a faster return to sporting activities than invasive treatment in patients who were monitored for up to one year.
- Primary surgery reduces the level of residual complaints in terms of functional instability and recurrent sprains, as indicated by patient self-assessment after six weeks.

A recent systematic review of the effectiveness of various conservative forms of treatment that was carried out by de Bie et al.⁵⁶ confirmed Van der Ent's first two conclusions.⁷⁹ They found that the use of plaster casts also seems to increase significantly the

amount of work absenteeism, by an average of five days, whereas taping reduces absenteeism significantly. A meta-analysis carried out by Kannus and Renstrom²⁴ showed that class 1 and class 2 injuries healed extremely well with non-surgical functional treatment. In their conclusions, the researchers suggested that functional treatment should comprise the following elements: immediately after the trauma, initiate rest, cryotherapy, compression and elevation (i.e., RICE = Rest, Ice, Compression, Elevation), which should be followed in phase 2 by a short period of immobilization using taping to control pain and swelling. Finally, in phase 3, the patient should undertake active exercise to reduce impairments affecting, for example, mobility, stability and muscle strength, and to improve abilities, such as walking, using stairs, and performing activities associated with normal daily living and with sports.

Most studies in which surgery combined with immobilization using a plaster cast was compared with immobilization using a plaster cast alone showed that conservative treatment (i.e., just the plaster cast) was preferable to surgery combined with a plaster cast.^{80–82} All studies indicate that early mobilization produces better results. However, the authors of one study argued in favor of surgery as the treatment of first choice.⁸³ Nevertheless, functional treatment was preferred by most.^{20,22,24,35,84–88}

There is considerable controversy in the literature about the best treatment for acute complete ruptures (class 3 injuries) because the long-term prognosis is excellent irrespective of the treatment given. Therefore, functional treatment is clearly the treatment of first choice for complete ruptures.²⁴ Surgery is more expensive, damages other tissues and entails the risk of complications. Moreover, in 10% of cases, a second operation is needed.²⁴ Surgery should be considered only in cases of major avulsion fractures or severe damage to both medial and lateral ligaments.

Numerous randomized clinical trials comparing surgery with conservative treatment or comparing the various types of conservative treatment with each other have been carried out, such as those by Brink et

al.,⁷⁶ Brooks et al.,⁸⁴ Eiff et al.,⁸⁹ van der Ent,⁷⁹ Freeman,³¹ Gronmark et al.,⁹⁰ O'Hara et al.,⁹¹ Klein et al.,^{81,85,92} Korkala et al.,⁹³ Linde et al.,⁹⁴ Moller-Larsen et al.,⁸⁶ Oostendorp,²² Scotece et al.,⁹⁵ Sommer and Arza,⁸⁷ and Zwiipp and Schievink.⁸⁸ Not one study found that immobilization using a plaster cast was by itself the best treatment choice. This was the case whether the outcome of treatment was assessed in terms of the level of recovery (for example, as indicated by stability or talar tilt) or the speed of recovery. Most authors favored a conservative approach involving functional treatment.

In the subacute phase, the adoption of a conservative approach can comprise the application of taping or bandages and the provision of exercise therapy. The individual goals of treatment can be pursued by reducing the patient's impairments and improving his abilities. In addition, a key element of treatment is to increase load gradually to improve walking ability (i.e., functional gait training), muscle strength, and coordination, thereby ultimately improving proprioceptive control and lessening the feeling that the ankle is "giving way". The most important goal of treatment is to restore abilities such as walking, load-bearing and playing sports as quickly as possible by providing exercise. Here, the emphasis is clearly on treating functional instability rather than mechanical

instability.

Several studies^{22,78,84,85} and a meta-analysis carried out by Kannus and Renstrom²⁴ show that exercise therapy adds nothing to the end result over the long term. However, the studies also show that exercise therapy, as described above, enables patients to return to carrying out normal daily activities significantly more quickly over the short term.

Effectiveness of using tape or braces

The preventive effects of using tape or braces

Literature reports indicate that the use of tape or braces has a significant effect in preventing both primary and secondary injuries.⁹⁶ A 40–50% reduction in both the number of primary injuries and the number of relapses has been reported.^{69,96–98} Table 5 summarizes the main conclusions of a systematic review carried out by Quinn et al.⁹⁶

The preventive effects of using tape during sporting activities

The function of tape is two-fold.^{97–99} Firstly, it has a mechanical or stabilizing effect that reduces the range of movement involved in plantar flexion and inversion. This effect is very important when there is insufficient muscular strength or secondary atrophy of evtor muscles, or both, as, otherwise, the muscles would not be able to make these movements.⁶⁹ The

Table 5. Summary of the most significant effects of using tape or braces on the prevention of primary and secondary injuries of the lateral capsular ligament, as reported in a systematic review carried out by Quinn et al.(96) OR = odds ratio; CI = confidence interval.

Effect of interventions compared with control treatment	OR (95% CI)
Primary prevention	
• Ankle braces / orthoses reduce ankle injuries;§	0.47 (0.35–0.63)
• Coordination exercises by means of ankle disc training reduce ankle injuries.	0.30 (0.15–0.60)
Secondary prevention	
• Ankle braces/orthoses reduce the number of injuries	0.49 (0.37–0.66)
• Significant benefit for those with previous sprain using ankle orthoses or external support	0.31 (0.19–0.49)
• significant result for those without prior history of ankle sprains	0.70 (0.47–1.03)
• protective effect of ankle orthoses was similar for mild sprains	0.40 (0.23–0.70) vs.
• and more severe sprains	0.54 (0.36–0.80)

second function of taping is to influence muscular activity around the joint by affecting proprioceptive reflexes. The literature on this phenomenon is unclear. Both positive (100) and negative (99) effects on the response time and contraction strength of the peroneus muscles have been reported. Von Karlsson and Andreasson (66) showed that taping a mechanically stable ankle delayed responses in these muscles. The proprioceptive effect of taping for preventive purposes is beneficial only in people with recurrent injuries.

Very little work has been done on comparing the effects of different taping techniques on mechanical restriction.(99) The basket-weave method, with 'stirrups' and a 'heel lock', is considered best.(101,102) Also, the Coumans bandage has proved to be effective.(35)

Function and effectiveness of braces

A review of the literature shows that considerable research has been done on the effects of braces and on comparing the effectiveness of different types of braces. To date, no one brace has emerged as the clear favorite. Each has its own advantages and disadvantages in terms of its fit, comfort and degree of mechanical restriction. In summary, the different types of braces are:

- the elastic brace: a brace that is fixed in position with tape and that allows the degree of mechanical restriction to be determined up to a certain height;
- the lace-on brace: a brace with laces and medial and lateral stiffening; and
- the semi-rigid brace: a brace with inserts that provide passive support to the medial and lateral side of the ankle. This brace is fixed in position using tape.

Overall, it can be concluded that the more elastic a brace is, the more comfortable it is to wear and the less mechanical restriction it causes. Rigid braces are less comfortable and produce greater mechanical restriction. The type of brace chosen will depend on the information obtained during history-taking and the physical therapy diagnostic examination, and should take into account the patient's own desires and requirements.

A review of the literature shows that most studies focused on the value of ankle braces in preventing ankle sprains during sporting activities.(56,69,103–109) Consequently, recommendations based on these studies apply to phases 3 and 4 of treatment for patients who have suffered traumatic injury of the lateral capsular ligament of the ankle. It is, therefore, not possible to judge scientifically the value of using braces in treatment phases 1 and 2 as defined in these guidelines.

Comparative studies of using tape or braces

Taping restricts the range of movement during sporting activities 25% more than the use of a brace.(110) However, taping is subject to a significant 'loosening' effect during sporting activities. This can be as much as 40–50% within a few hours, depending on the nature of the activity.(101,111) Both taping and braces restrict the range of movement by up to 30%.(111,112) Although braces are subject to a loosening effect of 4.5–12%,(110) it is easy to restore the original effect by tightening the brace using tapes or laces. Finally, the effect of using tape or a brace on mechanical stability after exertion is the same.(110,113)

Both techniques have advantages and disadvantages. In addition to the loosening effect, taping has other negative characteristics. Most frequently mentioned are the high cost, the skin irritation caused by the adhesive, and the difficulty of removing the tape. The main benefit is that taping can be adapted to the patient's particular situation should more or less stabilization be needed during the course of therapy.

The loosening effect can partially be overcome by using a brace. In addition, braces are easy to put on and take off, and are less hard on the skin than tape. One drawback is that getting a good fit is difficult, as is putting the patient's shoe back on the affected foot once the brace is in place, thereby possibly causing skin irritation.(114) A good brace must strike the right balance between comfort and support (103) and is, therefore, an individual choice.

As both tape and braces provide good stabilization and as they are both equally effective in preventing

injury, the guidelines recommended them both as alternative ways of treating injuries of the lateral capsular ligament of the ankle. The use of tape or braces is not effective in primary prevention.

The use of tape or braces

The use of tape or a brace is especially helpful before coordination training has been completed.^{69,97,99}

These techniques are also valuable in special situations in which the risk of injury is greater than normal,⁶⁹ for example, when there is active instability, tiredness brought on by sporting activities, or recurrent injuries. The working group suggests, therefore, that tape or a brace should be used when the ankle is exposed to the severe stress involved in returning to a high-risk job or to sporting activities. Use of these techniques can be reduced as the patient's coordination and proprioceptive responses improve.^{35,100,115,116}

Footwear.

There is no consensus about footwear in the literature. Some authors advocate high-sided footwear,^{97,106} whereas others recommend low-sided footwear.¹¹⁷ As no clear indications are given in the literature, the working group recommends using footwear that is appropriate for the normal daily activity, sporting activity, or surface concerned.

The preventive effect of warming-up and cooling-down exercises

Although it is generally assumed that warming-up exercises, such as stretching, and cooling-down exercises play important parts in preventing sports injuries, little scientific research has been carried out in this area. One group of researchers^{118,119} conducted a prospective study on the link between muscle stiffness, muscle strength and differences in muscle strength levels on the one hand and the risk of running injuries on the other. The intervention in this study consisted of warming-up exercises, which included stretching, and cooling-down exercises. This intervention did not appear to affect the incidence of injury.

Treatment conclusion and reporting

At the conclusion of treatment, a physical therapy

report should be written and another report should be sent to the referring physician. These reports should be made in accordance with KNGF guidelines entitled "Communicating with and reporting back to general practitioners"¹²⁰ and "Physiotherapeutic documentation and reporting".¹²¹

The legal significance of the guidelines

These guidelines are not statutory regulations. They provide knowledge and make recommendations based on the results of scientific research, which healthcare workers must take into account fully if high-quality care is to be provided. Since the recommendations mainly refer to the average patient, healthcare workers must use their professional judgement to decide when to deviate from the guidelines if that is required in a particular patient's situation. Whenever there is a deviation from guideline recommendations, it must be justified and documented.^{4,5}

Revisions

These guidelines on diagnosis, treatment and injury prevention in patients with lateral ankle injuries are the first such clinical guidelines developed by the KNGF. Subsequent developments that could lead to improvements in the application of physical therapy in this group of patients may have an impact on the knowledge contained in these guidelines. The prescribed method for developing and implementing guidelines in general proposes that all guidelines should be revised a maximum of three to five years after the original publication.^{4,5} For these guidelines on acute ankle sprain, this means that the KNGF, together with the working group, should decide whether the guidelines are still accurate by 2003 at the latest. If necessary, a new working group will be set up to revise the guidelines. The guidelines will no longer be valid if there are new developments that necessitate a revision. Before any revision is carried out, the recommended method of guideline development and implementation should also be updated on the basis of any new insights and should take into account any cooperative agreements made between the different groups of guideline developers working in the Netherlands. The details of any

consensus reached by Evidence-Based Guidelines Meetings (i.e., the EBRO platform), which are organized under the auspices of the CBO, will also be taken into account in any updated version of the method of guideline development and implementation. For example, the stipulation that uniform and transparent methods are necessary for determining the amount of evidence needed and for deriving practice recommendations would constitute an important improvement.

Acknowledgements

For their help in producing the KNGF guidelines, special thanks are given to the members of the

secondary working group: Dr CN van Dijk (orthopedic surgeon, University Medical Center, Amsterdam) and Dr RJ Benink (orthopedic surgeon, St Gemini Hospital, Den Helder), both belonging the Dutch Orthopedic Association, and Dr AN Goudswaard (primary care physician) and staff at the Dutch Society of General Practitioners (NHG) in Utrecht.

The production of these guidelines was subsidized by the (Dutch) Ministry of Public Healthcare, Welfare and Sport (vws) within the framework of a program entitled "A quality support policy for allied health professions (OKPZ)".

List of abbreviations and glossary

CBO	(Dutch) Collaborating Center for Quality Assurance in Healthcare
CI	Confidence interval
KNGF	Royal Dutch Society for Physical Therapy
NHG	Dutch College of General Practitioners

Activity	Execution of a task or action by an individual
Acute ankle sprain	Traumatic injury to the lateral capsular ligament of the ankle that is diagnosed within 72 hours of occurrence
95% CI	A range of values within which there is a 0.95 probability that the real value of a measured parameter is included
Disability	Inability to perform an activity in the manner or to the extent considered normal for that person
Function	Physiological functions of body systems (including psychological functions)
Immobility	Insufficient physical exercise or level of physical activity
Impairment	Problem with body function or structure, such as a significant deviation or loss
Incidence of acute ankle sprain	Number of new acute ankle sprains occurring in a certain period
Prevalence of acute ankle sprain	Number of acute ankle sprains present at a certain point in time
Odds ratio	The fractional probability that an experimental patient will suffering an adverse event relative to a control patient
Structure	Anatomical part of the body, such as an organ or limb or its component
Systematic review	A systematic review of the scientific literature in which the conclusion describes (qualitatively) the results of all the studies found on a particular topic

References

- 1 CBO consensus diagnostiek en behandeling van het acute enkelletsel Utrecht, the Netherlands: CBO; 1998.
- 2 Goudswaard AN, Thomas S, van den Bosch WJHM, van Weert HCPM, Geijer RMM. NHG-standaard enkeldistorsie. Huisarts Wet 2000;43(1):32.
- 3 Hendriks HJM, Reitsma E, van Ettekovén H. Centrale richtlijnen in de fysiotherapie. Ned Tijdschr Fysiother 1996;106:2-11.
- 4 Hendriks HJM, van Ettekovén H, Reitsma E, Verhoeven ALJ, van der Wees PJ. Methode voor centrale richtlijnontwikkeling en implementatie in de fysiotherapie. Amersfoort, the Netherlands: KNGF/NPI/CBO; 1998.
- 5 Hendriks HJM, Bekkering GE, van Ettekovén H, Brandsma JW, van der Wees PJ, de Bie RA. Development and implementation of national practice guidelines: a prospect for continuous quality improvement in physiotherapy. Introduction to the method of guideline development. Physiotherapy 2000;86:535-47.
- 6 Sackett DL, Hayens RB, Guyatt GH, Tugwelle P. Clinical epidemiology: a basic science for clinical medicine. Toronto, Canada: Little, Brown and Company; 1985.
- 7 Roebroek ME, Dekker J, Oostendorp RAB, Bosveld W. Physiotherapy for patients with lateral ankle sprains: a prospective survey of practice patterns in Dutch primary health care. Physiotherapy 1998;84:421-32.
- 8 Hendriks HJM, van Ettekovén H, van der Wees PJ. Eindverslag van het project centrale richtlijnen in de fysiotherapie (Deel 1): achtergronden en evaluatie van het project. Amersfoort, the Netherlands: KNGF/NPI/CBO; 1998.
- 9 Publicatie van de KNGF-richtlijn acuut enkelletsel is een feit! Fysiopraxis 1998;7:3-4. Deskundigheidsbevorderingspakket KNGF-richtlijn Acuut Enkelletsel. Fysiopraxis 1998;(7, supplement).
- 10 Hendriks E, van Ettekovén H, Bekkering T, Verhoeven A. Implementatie van NGF-richtlijnen. Fysiopraxis 2000;9:9-13.
- 11 Schmikli JG, Bakx JG. Sportblessures nader uitgediept. Houten/Diegem, the Netherlands: Bohn Tafleu Van Loghum; 1995.
- 12 Hunter G. Specific soft tissue mobilisation in the treatment of soft tissue lesions. Physiotherapy 1994;80(1):15-21.
- 13 Birrer RB, Cartwright TJ, Denton JR. Primary treatment of ankle trauma. Physician Sports Med 1994;22(11):33-42.
- 14 Van Dijk CN. On diagnostic strategies in patients with severe ankle sprains (thesis). Amsterdam, the Netherlands: Rodopi; 1994.
- 15 Van der Zee J. NIVEL: Continue Morbiditeits Registratie. Utrecht, the Netherlands: Boekbinderij Post; 1993.
- 16 Bol E, Schmickli SL, Backx FJG et al. Sportblessures onder de knie: programmering van toekomstig onderzoek. NISGZ; March 1991.
- 17 Dunning AJ et al. Kiezen en delen: advies in hoofdzaken van de commissie keuzen in de zorg. VDB 91-340, tweede oplage. Den Haag, the Netherlands: 1991.
- 18 Rens TG. Rupturen van de laterale enkelband(en): opereren of niet? Ned Tijdschr Geneesk 1986;130(11):480-4.
- 19 Von Karlsson J, Linsinger O. Chronic lateral instability of the ankle in athletes. Sports Med 1993;16(5):355-65.
- 20 Freeman MAR. Treatment of ruptures of the lateral ligament of the ankle. J Bone Joint Surg 1965;47-B(4):661-8.
- 21 Brostrom L. Sprained ankles. V: Treatment and prognosis in recent ligament ruptures. Acta Chir Scand 1966;132:537-50.
- 22 Oostendorp RAB. Functionele instabiliteit na het inversietrauma van de enkel en voet: een effectonderzoek pleisterbandage versus pleisterbandage met fysiotherapie. Geneesk Sport 1987;20(2):45-55.
- 23 De Maio. Chronic lateral ankle instability: inversion sprains. Clin Orthop 1992;15(1):87-96.
- 24 Kannus P, Renström P. Treatment for acute tears of the lateral ligaments of the ankle. J Bone Joint Surg 1991;73-A:305-12.
- 25 Stiel IG, Greenberg GH, McKnight RD, Nair RC, McDowell I, Worthington JR. A study to develop clinical decision rules for the use of radiography in acute ankle injuries. Ann Emerg Med 1992;21:384-90.
- 26 Stiel IG, Greenberg GH, McKnight RD, Nair RC, McDowell I, Worthington JR. Decision rules for the use of radiography in acute ankle injuries: refinement and prospective validation. JAMA 1993;269:1127-32.
- 27 Stiel IG, McKnight RD, Greenberg GH et al. Implementation of the Ottawa ankle rules. JAMA 1994;271:827-32.
- 28 Stiel IG, Wells G, Laupacis A et al. Multicentre trial to introduce the Ottawa ankle rules for use of radiography in acute ankle injuries. BMJ 1995;311:594-7.
- 29 De Bie RA, de Vet HCW, Lenssen T. The prognosis of ankle sprains. Int J Sports Med 1997;18:285-9.
- 30 Chandani VP, Harper MT, Ficke JR et al. Chronic ankle instability: evaluation with MR arthrography, MR imaging and stress radiography. Radiology 1994;192:189-94.
- 31 Freeman MAR. Coordination exercises in the treatment of functional instability of the foot. Physiotherapy 1965;39:3-5.
- 32 Perlman M, Leveille D, DeLeonibus J et al. Inversion lateral ankle trauma: review of the literature, and prospective study. J Foot Surg 1987;26(2):95-135.
- 33 Wilkerson GB, Nitz AJ. Dynamic ankle instability: mechanical and neuromuscular interrelationships. J Sport Rehab 1994;3:43-57.
- 34 Glasgow M, Jackson A, Jamieson AM. Instability of the ankle after injury to the lateral ligament. J Bone Joint Surg 1980;62-B:196-200.
- 35 Van Moppes FI, van den Hoogenband CR. Diagnostic and therapeutic aspects of inversion trauma of the ankle joint (dissertation). Maastricht, the Netherlands: 1982.
- 36 Reed B, Zarro V. Inflammation and repair and the use of thermal agents. In: Michlovitz SL, editor. Thermal agents in rehabilitation. Philadelphia: FA Davis Co; 1986.
- 37 Prentice WE, Bell GW. Pathophysiology of musculoskeletal injuries and the healing process. In: Prentice WE. Rehabilitation techniques in sports medicine. St Louis: Times Mirror/Mosby College Publ; 1990.
- 38 Howell DW. Therapeutic exercise and mobilization. In: Hunt GC. Physical therapy of the foot and ankle. New York: Churchill Livingstone; 1988.
- 39 Cote DJ, Prentice WE, Hooker DN, Shields EW. Comparison of three treatment procedures for minimizing ankle sprain swelling. Phys Ther 1988;68(7):1072.
- 40 Hocutt JE, Jaffe R, Rylander CR Beebe JK. Cryotherapy in ankle sprains. Am J Sports Med 1982;10:316.
- 41 McMaster WC. Cryotherapy. Physician Sports Med 1982;10(11):112-9.
- 42 Griffin JE, Karselis TC. Physical agents for physical therapists. Springfield, IL: Charles C Thomas Publ; 1978; 165-74.

- 43 McCluskey GM, Blackburn TA, Lewis T. A treatment for ankle sprains. *Am J Sports Med* 1976;4:158-61.
- 44 Cooper DL, Fair J. Contrast baths and pressure treatment for ankle sprains. *Physician Sports Med* 1979;7(4):143.
- 45 Kalenak A, Medlar CE, Fleagle SB, Hochberg WJ. Athletic injuries: heat vs. cold. *Am Family Phys* 1975;12:131.
- 46 Barnes L. Cryotherapy: putting injury on ice. *Phys Sports Med* 1979;7(6):130-6.
- 47 Wallace L, Knortz K, Esterson P. Immediate care of ankle injuries. *J Orthop Sports Phys Ther* 1979;1:46-50.
- 48 Rucinsky JJ, Hooker DN, Prentice WE, Shields EW et al. The effects of intermittent compression on oedema in postacute ankle sprains. *J Orthop Sports Phys Ther* 1991;14(2):65-9.
- 49 Wilkerson GB, Horn-Kingery HM. Treatment of the inversion ankle sprain: comparison of different modes of compression and cryotherapy. *J Orthop Sports Phys Ther* 1993;17(5):240-6.
- 50 Balduini FC, Vegso JJ, Torg JS, Torg E. Management and rehabilitation of ligamentous injuries to the ankle. *Sports Med* 1987;4:364-80.
- 51 Meeusen R, Lievens P. The use of cryotherapy in sports injuries. *Sports Med* 1986;3:398-414.
- 52 McMaster WC. A literary review of ice therapy on injuries. *Am J Sports Med* 1977;5:124.
- 53 Vegso JJ, Harmon LE. Nonoperative management of athletic ankle injuries. *Clin Sports Med* 1982;1:85.
- 54 Williamson JB, George TK, Simpson DC, Hannah B et al. Ultrasound in the treatment of ankle sprains. *Injury* 1986;17:176-8.
- 55 Von Lilius HG, Valtonen EJ, Pasila M, Visuri TI et al. Über die therapeutische Wirkung der dia-dynamischen Ströme an Bänderverletzungen des Fusses, Kontrollierte Untersuchung an 248 Patienten. *Zschr Physiother* 1975;27:331-4.
- 56 De Bie RA, Verhagen AP, Lenssen AF, de Vet HCW, van den Wildenberg FAJM, Kootstra G et al. Efficacy of conservative interventions in the treatment of acute lateral ankle sprains: a systematic review. In: de Bie RA. *Efficacy of 904-nm laser therapy in acute lateral ankle sprains (thesis)*. Maastricht University, the Netherlands: Academie Press; 1998.
- 57 Wilson DH. Treatment of soft-tissue injuries by pulsed electrical energy. *Br Med J* 1972;2:269-70.
- 58 Barker AT, Barlow PS, Porter J, Smith ME et al. A double-blind clinical trial of lower-power pulsed short-wave therapy in the treatment of a soft tissue injury. *Phys Ther* 1985;71(12):500-4.
- 59 Michlovitz S, Smith W, Watkins M. Ice and high-voltage pulsed stimulation in treatment of acute lateral ankle sprains. *J Orthop Sports Phys Ther* 1988;9(90).
- 60 Pasila M, Visuri T, Sundholm A. Pulsating short-wave diathermy: value in treatment of recent ankle and foot sprains. *Arch Phys Med Rehab* 1978;59(8):383-6.
- 61 Pennington MAJGM, Danley LTCDL, Sumko MAJMH. Pulsed, non-thermal, high-frequency electromagnetic energy in the treatment of grade-I and grade-II ankle sprains. *Military Med* 1993;158(2):101.
- 62 Scher AT. Anterior cervical subluxation: an unstable position. *AJR* 1979;133:275-80.
- 63 White AA, Panjabi M. *Clinical biomechanics of the spine*. Philadelphia: JB Lippincott Company; 1978.
- 64 Swinkels RAHM, Oostendorp RAB. Upper-cervical instability: fact of fiction? *J Man Physiol Ther* 1996;1(3):185-94.
- 65 Swinkels R, Beeton K, Alltree J. Pathogenesis of upper cervical instability. *Man Ther* 1996;1:127-32.
- 66 Karlsson J, Andreasson GO. The effect of external ankle support in chronic lateral ankle instability: an electromyographic study. *Am J Sports Med* 1992;20:257-61.
- 67 Panjabi MM. The stabilizing system of the spine. Part 1: function, dysfunction, adaptation and enhancement. *J Spinal Disorders* 1992;5:383-9.
- 68 Panjabi MM. The stabilizing system of the spine. Part 2: neutral zone and instability hypothesis. *J Spinal Disorders* 1992;5:390-7.
- 69 Tropp H, Askling C, Gillquist J. Prevention of ankle sprains. *Am J Sports Med* 1985;13(4):259-62.
- 70 Barrett DS. Proprioception and function after anterior cruciate reconstruction. *J Bone Joint Surg* 1991;73-B(5):833-7.
- 71 Kottke FJ, Halpern D, Easton JKM et al. The training of coordination. *Arch Phys Ed Rehab* 1978;59(Dec):567-57.
- 72 Oostendorp RAB, van de Sande JAW. Arthrokinetische reacties en musculaire stabiliteit. *Ned Tijdschr Fysiother* 1983;93(2):63-72.
- 73 Trevino SG, Davis P, Hecht P. Management of acute and chronic lateral ligament injuries of the ankle. *Orthop Clin North Am* 1994;25(1):1-16.
- 74 Tropp H, Ekstrand J, Gillquist J. Factors affecting stabilometry recordings of single limb stance. *Am J Sports Med* 1984;12(3):185-8.
- 75 Tropp H, Ekstrand J, Gillquist J. Stabilometry in functional instability of the ankle and its value in predicting injury. *Med Sci Sports Exerc* 1984;16(1):64-6.
- 76 Brink PRG, Runne WC, Wever J. De functionele behandeling van rupturen van de laterale enkelband. *Ned Tijdschr Geneesk* 1988;132(15).
- 77 Ferrell WR, Baxendale RH, Carnachan C et al. The influence of joint afferent discharge on locomotion, proprioception and activity in conscious cats. *Brain Res* 1985;347:41-8.
- 78 Wester JIJ, Jespersen SM, Nielsen KD, Neumann L. Wobble-board training after partial sprains of the lateral ligaments of the ankle: a prospective randomized study. *J Orthop Sports Phys Ther* 1996;23(5):332-6.
- 79 Van der Ent FWC. Letsels van het laterale enkelbandapparaat: conservatieve en operatieve therapie. *Ned Tijdschr Fysiother* 1989;99(4 April):82-6.
- 80 Evans GA, Hardcastle P, Frenyo AD. Acute rupture of the lateral ligament of the ankle. To suture or not to suture? *J Bone Joint Surg* 1984;66-B(2):209-12.
- 81 Klein J, Schreckenberger C, Räddecker K et al. Operative oder konservative Behandlung der frischen Aussenbandruptur am oberen Sprunggelenk. Randomisierte klinische Studie. *Unfallchir* 1988;91:154-60.
- 82 Niedermann B, Andersen A, Andersen SB, Funder V, Jorgensen JP, Lindholmer E et al. Rupture of the lateral ligaments of the ankle: operation or plaster cast? A prospective study. *Acta Orthop Scand* 1981;52:579-87.
- 83 Prins JG. *Diagnosis and treatment of injury to the lateral ligament of the ankle (dissertation)*. Leiden, the Netherlands. *Acta Chir Scand* 1978; Supp1486.
- 84 Brooks SC, Potter BT, Rainey JB. Treatment for partial tears of the lateral ligament of the ankle: a prospective trial. *Br Med J* 1981;282:606-9.
- 85 Klein J, Höher J, Tilling T. Comparative study of therapies for fibular ligament rupture of the lateral ankle joint in competitive basketball players. *Foot Ankle* 1993;14(6 Aug):320-4.
- 86 Moller-Larsen F, Wethelund JO, Jurik AG et al. Comparison of three different treatments for ruptures of lateral ankle

- ligaments. *Acta Orthop Scand* 1988;59:564-6.
- 87 Sommer HM, Arza D. Functional treatment of recent ruptures of the fibular ligament of the ankle. *Int Orthop* 1989;13:157-60.
- 88 Zwipp H, Schievink B. Primary orthotic treatment of ruptured ankle ligaments: a recommended procedure. *Prosthet Orth Int* 1992;16:49-56.
- 89 Eiff MP, Smith AT, Smith GA. Early mobilization versus immobilization in treatment of lateral ankle sprains. *Am J Sports Med* 1994;1:83-8.
- 90 Gronmark T, Johnsen O, Kogstad O. Rupture of the lateral ligaments of the ankle: a controlled clinical trial. *Injury* 1980;2:215-8.
- 91 O'Hara J, Valle-jones JC, Walsh H et al. Controlled trial of an ankle support (Malleotrain) in acute ankle injuries. *Br J Sports Med* 1992;26(3):139-43.
- 92 Klein J, Rixen D, Albring T, Tilling T. Funktionelle versus Gipsbehandlung bei der frischen Aussenbandruptur des oberen Sprunggelenks. *Unfallchir* 1991;94:99-104.
- 93 Korkala O, Rusanen M, Jokipii P et al. A prospective study of the treatment of severe tears of the lateral ligament of the ankle. *Int Orthop* 1987;11:13-7.
- 94 Linde F, Hvass L, Jurgenson U, Madsen F. Compression bandage in the treatment of ankle sprains. *Scand J Rehab Med* 1984;16:177-9.
- 95 Scotecce GG, Guthrie MR. Comparison of three treatment approaches for grade-I and -II ankle sprains in active duty soldiers. *J Orthop Sports Phys Ther* 1992;15(1):19-22.
- 96 Quinn K, Parker P, de Bie R, Rowe B, Handoll H. Musculoskeletal injuries module of the Cochrane database of systematic reviews: the prevention of ankle ligament injuries (updated 01 September 1997). Available from the Cochrane Library (database on disk and CD-ROM). The Cochrane Collaboration, Issue 4. Oxford, UK: Update software, Updated quarterly; 1997.
- 97 Thorndike AJ. Athletic injuries: prevention, diagnosis and treatment. Philadelphia: Lea and Febiger; 1956;56-60.
- 98 Garrick JC, Requa RK. Role of external support in the prevention of ankle sprains. *Med Sci Sports* 1973;5:200-3.
- 99 Firer P. Effectiveness of taping for the prevention of ankle ligament sprains. *Br J Sports Med* 1990;24(1):47-50.
- 100 Rarick GL, Bigley G, Karst R, Malina RM. The measurable support of the ankle joint by conventional methods of taping. *J Bone Joint Surg* 1962;44:1183-90.
- 101 Van Wingerden BAR. Tape en bandagetechnieken. Lochem, the Netherlands: Uitgeverij De Tijdstroom; 1982.
- 102 Von Karlsson J, Sward L, Andreasson GO. The effect of taping on ankle stability. *Sports Med* 1993;16(3):210-5.
- 103 Glick JM, Gorden RB, Nishimoto D. The prevention and treatment of ankle injuries. *Am J Sports Med* 1976;4(4):136-41.
- 104 Alves JW, Alday RV, Ketcham DL, Lentell GL. A comparison of the passive support provided by various ankle braces. *J Orthop Sports Phys Ther* 1992;15(1):10-8.
- 105 Tracy A, Greene MA, Colleen R, Wight MA. A comparative support evaluation of three ankle orthoses before, during, and after exercise. *J Orthop Sports Phys Ther* 1990;12(11):453-66.
- 106 Beynnon BD, Renström PA. The effect of bracing and taping in sports. *Ann Chir Gynaecol* 1991;80:230-8.
- 107 Shapiro MS, Kabo JM, Mitchell PW, Loren G, Tsenten M. Ankle sprain prophylaxis: an analysis of the stabilizing effects of braces and tape. *Am J Sports Med* 1994;22(1):78-82.
- 108 Johnson RE, Veale JR, McCarthy GJ. Comparative study of ankle support devices. *J Am Podiatric Med Ass* 1994;84(3):107-14.
- 109 Gross MT, Everts JR, Roberson SE, Roskin DS, Young KD. Effect of Donjoy ankle ligament protector and Aircast Sport-Stirrup orthoses on functional performance. *J Orthop Sports Phys Ther* 1994;19(3):150-6.
- 110 Stiggelbout M, van Mechelen W. De preventieve waarde van de enkelbrace in vergelijking tot enkeltaping ter voorkoming van enkeldistorsies bij sporters. *Geneesk Sport* 1993;26(1).
- 111 Bunch RP, Bednarski K, Holland D et al. Ankle joint support: a comparison of reusable lace-on braces with taping and wrapping. *Phys Sports Med* 1985;13(5):59-62.
- 112 Fumich RM, Ellison AE, Geurin GJ, Grace PD. The measured effect of taping on combined foot and ankle motion before and after exercise. *Am J Sports Med* 1981;9:165-70.
- 113 Myburg KH, Baughan CL, Isaacs SK. The effects of ankle guards and taping on joint motion before and after exercise. *Am J Sports Med* 1984;12:441-6.
- 114 Hughes LH, Stetts DM. A comparison of ankle taping and a semi-rigid support. *Physician Sports Med* 1983;11(4).
- 115 Perrin DH. Athletic taping and bracing. Champaign, USA: Human Kinetics; 1995.
- 116 Rovere GD, Clarke TL, Yates CS et al. Retrospective comparison of taping and ankle stabilizers in preventing ankle injuries. *Am J Sports Med* 1988;16:228-33.
- 117 Leemrijse C. Gaat bij chronische instabiliteit van de enkel de voorkeur uit naar bandageren/tapen of pushbraces? *Respons* 1990;1(5).
- 118 Van Mechelen W. Aetiology and prevention of running injuries (thesis). Amsterdam, the Netherlands: Drukkerij A1/A2; 1992.
- 119 Van Mechelen W, Hlobil H, Kemper HCG, Voorn WJ, de Jongh R. Prevention of running injuries by warm-up, cool-down, and stretching exercises. *Am J Sports Med* 1993;21(5):711-9.
- 120 Verhoeven ALJ, van den Heuvel CME. KNGF-Richtlijn 'Informatieverstrekkende huisarts'. Amersfoort, the Netherlands: KNGF; 1995.
- 121 KNGF. Richtlijnen voor de fysiotherapeutische verslaglegging. Amersfoort, the Netherlands: KNGF; 1993.