Re-sprains during the first 3 months after initial ankle sprain are related to incomplete recovery: an observational study

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Question: What are prognostic factors for incomplete recovery, instability, re-sprains and pain intensity 12 months after patients consult primary care practitioners for acute ankle sprains? **Design**: Observational study. **Participants**: One hundred and two patients who consulted their general practitioner or an emergency department for an acute ankle sprain were included in the study. **Outcome measures**: Possible prognostic factors were assessed at baseline and at 3 months follow-up. Outcome measures assessed at 12 months follow-up were self-reported recovery, instability, re-sprains and pain intensity. **Results**: At 3 months follow-up, 65% of the participants reported instability and 24% reported one or more re-sprains. At 12 months follow-up, 55% still reported instability and more than 50% regarded themselves not completely recovered. None of the factors measured at baseline could predict the outcome at 12 months follow-up. Additionally, prognostic factors from the physical examination of the non-recovered participants at 3 months could not be identified. However, among the non-recovered participants at 3 months follow-up, re-sprains and self-reported pain at rest at 3 months were related to incomplete recovery at 12 months. **Conclusion**: A physical examination at 3 months follow-up for the non-recovered ankle sprain patient seems to have no additional value for predicting outcome at 12 months. However, for the non-recovered patients at 3 months follow-up, self-reported pain at rest and re-sprains during the first 3 months of follow-up seem to have a prognostic value for recovery at 12 months. **[van Middelkoop M, van Rijn RM, Verhaar JAN, Koes BW, Bierma-Zeinstra SMA (2012) Re-sprains during the first 3 months after initial ankle sprain are related to incomplete recovery: an observational study. *Journal of Physiotherapy* 58: 181–188]**

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Introduction

In the Netherlands an estimated 600 000 people sustain ankle injuries each year, an incidence of 12.8 per 1000 patients per year (Mulder et al 1995). Roughly half of these people visit a general practitioner or a hospital emergency department (Goudswaard et al 2000). Several studies have investigated the clinical course of pain of patients with acute ankle sprains (Konradsen et al 2002, Nilsson 1983, Pijnenburg et al 2003). During the first two months there is a rapid decrease in pain, after which the pain continues to improve more slowly. A systematic review showed that the proportion of patients who experience pain at one year of follow-up or later ranges from 16% to 33% (van Rijn et al 2008).

So far, there is no clear evidence that interventions such as (supervised) exercise will lead to benefits in subjective recovery, instability, re-sprains, or pain intensity (Kerkhoffs et al 2002, Ogilvie-Harris and Gilbart 1995, van Os et al 2005, van Rijn et al 2010, van Rijn et al 2007). In order to evaluate the effectiveness of therapeutic interventions and to guide management decisions, clear insight into the course of recovery after ankle sprain is needed. This information is helpful to inform patients about the expected clinical course and in the identification of relevant subgroups of patients with a better or worse prognosis.

The factors predicting persistent complaints from ankle sprains are largely unknown (van Rijn et al 2008). Until now, only one study has evaluated prognostic factors for incomplete recovery and re-sprains. Sporting activity at a high level was found to be a prognostic factor for residual symptoms (Linde et al 1986). However, this study showed methodological shortcomings and the full range and impact of residual complaints was not investigated (Braun 1999, Cross et al 2002, de Bie et al 1997, Linde et al 1986). Therefore our first research question was:

1. What are baseline prognostic factors for incomplete recovery, instability, re-sprains, and pain intensity during 12 months of follow-up in adult patients who consulted primary care for an acute lateral ankle sprain?

What is already known on this topic: Ankle sprains are common and a substantial proportion of these sprains do not fully resolve within one year. Ongoing instability and re-sprains are also common during the first year after the original sprain.

What this study adds: At the time of the sprain, none of a range of demographic and clinical factors accurately predicts incomplete recovery or re-sprains at one year. However, among patients whose sprain has not resolved within three months, re-sprains and self-reported pain at rest at three months were predictors of incomplete recovery at one year.

Because of the clinical course of ankle sprains, outcomes and factors at short-term follow-up could also have predictive value for long-term outcomes in a subgroup of non-recovered patients. Therefore, the second research question was:

2. What are possible prognostic factors for non-recovered patients at 3 months follow-up for the outcome at 12 months follow-up?

Method

Design

The data used for this study were derived from a randomised clinical trial investigating the effectiveness of supervised exercises for acute ankle sprain in primary care (van Rijn et al 2007). Patients who had an acute injury of the lateral collateral ligaments of the ankle and who presented themselves to one of the participating general practitioners or at an emergency department were considered for inclusion.

The general practitioner or emergency department physician carried out a standardised clinical examination. Based on these findings (stability, intensity and location of swelling, pain, and haemorrhage), the injuries were graded as mild, moderate, or severe (Birrer et al 1999).

After acquiring baseline information, each patient was randomised into either the usual care group or the physical therapy group. All participants (n = 102) in both groups received the same standard treatment from their physician (general information about early mobilisation, home exercises, early weight bearing, tape, bandage or brace). Participants in the physical therapy group participated additionally in an individual and progressive training program supervised by a physical therapist. All participants received standardised questionnaires at 3 and 12 months follow-up, and a standardised physical examination was performed at 3 months follow-up.

For the purpose of the present research question, the data from the randomised trial are analysed as a cohort study, because the trial showed no differences between the usual care group and the physical therapy group (van Rijn et al 2007). Nevertheless, in the present study the interventions were also considered as potential prognostic factors.

Participants

Patients with a lateral ankle sprain were eligible for this study if they were aged between 18 and 60 years and their first visit to the physician was within 1 week of the injury. Patients were excluded if they had a history of an injury of the same ankle during the previous two years or if they had ever had a fracture of the same ankle.

Outcome measures

All participants were asked to complete a baseline questionnaire containing questions about potential prognostic factors (Appendix 1, see the eAddenda for Appendix 1.) The following characteristics were measured at baseline: demographic factors (age, gender, body mass index), clinical factors (setting, intervention, injury grade, earlier injury, self-reported swelling, Ankle Function Score measured according to de Bie et al 1997, instability, and pain at rest, during walking and running), and ankle load factors (ankle load during work and ankle load during hobby/sports). Ankle load was determined by asking, 'Are your working/sporting tasks aggravating for your ankle?' Loading was categorised as none, light, or heavy.

Table 1. Baseline characteristics and potential prognostic factors of participants.

Characteristic	Participants (n = 102)
Age *(yr)*, mean (SD)	37 (12)
Gender, n males (%)	59 (58)
Body Mass Index, n (%)	
< 25 kg/m^2	50 (49)
≥ 25 kg/m^2	42 (41)
unknown	10 (10)
Injury grade, n (%)	
mild	43 (42)
moderate or severe	45 (44)
unknown	14 (14)
Setting, n (%)	
general practitioner	64 (63)
Emergency department	38 (37)
Treatment, n (%)	
physiotherapy	49 (48)
usual care	53 (52)
Earlier injury in past 2 yr, n (%)	
no	51 (50)
yes	44 (43)
unknown	7 (7)
Ankle load during work, n (%)	
none or light	65 (64)
heavy	31 (30)
unknown	6 (6)
Ankle load during sport/hobby, n (%)	
none or light	47 (46)
heavy	47 (46)
unknown	8 (8)
Ankle load during sport/hobby, n (%)	
none or light	30 (29)
moderate or severe	65 (64)
unknown	7 (7)

The outcome measures evaluated by questionnaires at 3 and 12 months follow-up were subjective recovery, instability, re-sprains, ankle function, and pain at rest, during walking, and during running. Subjective recovery was measured on a numerical rating scale (range 0–10, where 0 = no recovery and 10 = full recovery.) Subjective instability was measured using six questions about instability and a feeling of giving way: the degree of a feeling of giving way during walking on flat ground, walking on uneven ground, walking uphill, walking downhill, and sport activities (each measured on a numerical rating scale from 0 to 10), and instability (measured on a 6-point scale from 'never a feeling of giving way' to 'a feeling of giving way with every step'.) The outcome 'instability' was dichotomised as being 'present' if at least one answer to these six questions was positive, or 'absent' if the answers were negative on all six questions. Participants were asked whether any re-sprains had occurred, so re-sprains were self-reported. Ankle function

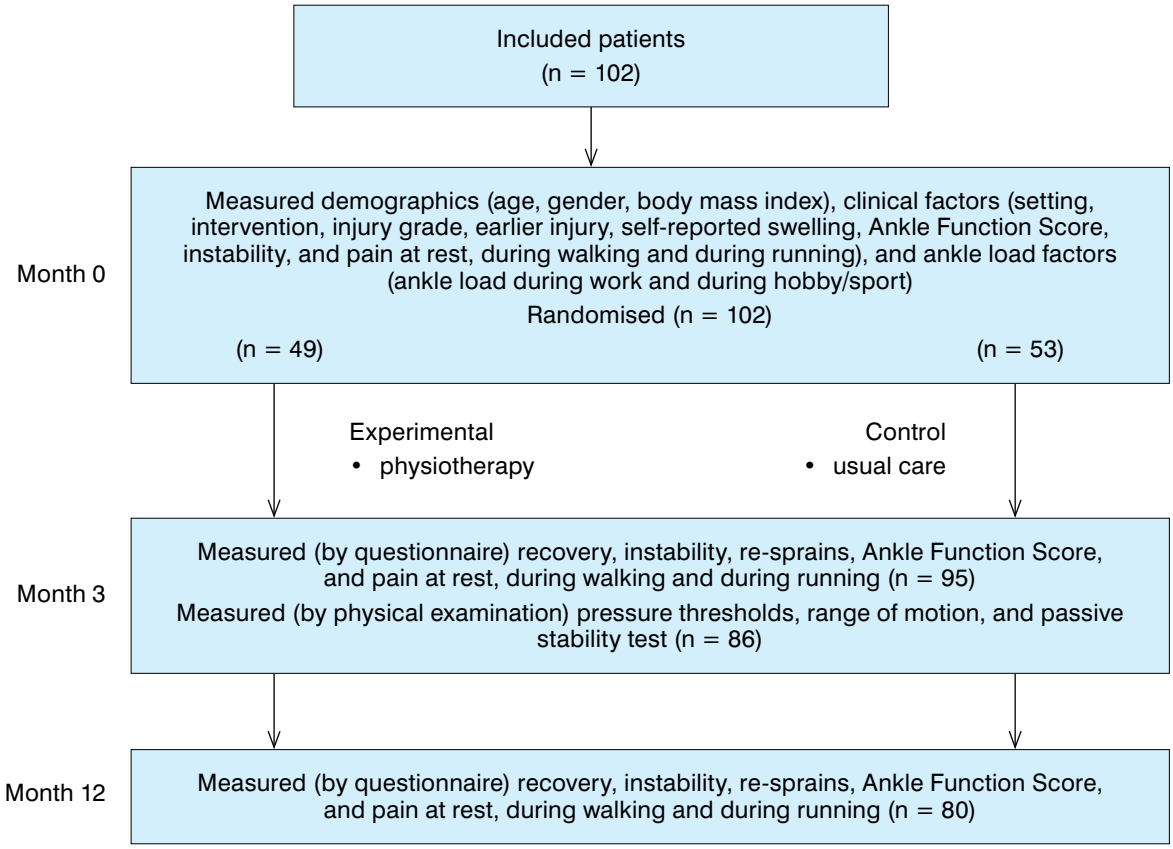

Figure 1. Design and flow of participants through the study.

was measured using the Ankle Function Score, which consists of five categories: pain, instability, weight bearing, swelling, and gait pattern. In each category, the number of points can be summed to a maximum overall score of 100, which indicates minimal severity (de Bie et al 1997). Pain intensity was measured on a numerical rating scale (range 0–10, where 0 = no pain and 10 = unbearable pain.)

One assessor, blinded for intervention but not for the other possible prognostic factors, conducted a standardised physical examination procedure at 3 months follow-up. This examination included pressure thresholds (tenderness on palpation) of the ventral, distal and dorsal malleoli lateralis, an active range of motion test (Gerber et al 1998), and a functional stability test that was a modification of Romberg's test (Freeman et al 1965). For the active range of motion test we used an electronic digital inclinometer[a]. Sitting with the knees in zero degrees and the ankle in maximal plantar flexion, participants performed maximal dorsiflexion of the ankle. We calculated the differences in score between the sprained and the unsprained ankle. Objective instability was assessed by participants standing on one leg for a maximum of one minute with the eyes open, and standing on one leg for a maximum of 30 seconds with the eyes closed. Balance time on one leg was recorded. Instability of the sprained ankle was scored positive when the sprained ankle was less stable than the non-sprained ankle.

These possible prognostic factors were taken in consideration for a subgroup analysis. The subgroup consisted of the non-recovered participants at 3 months follow-up and considered prognosis of their outcome at 12 months follow-up.

Data analysis

To reduce bias and improve efficiency, values were multiple imputed for the 9.6% of missing data in the dataset. We generated ten imputed datasets using chained equations (van Buuren et al 1999).

Descriptive statistics were applied to summarise patient characteristics and outcome. The outcome 'recovery' was dichotomised, with non-recovery being a score of 9 or lower on the 0–10 point scale, and full recovery a score of 10.

The following baseline characteristics were taken into consideration to evaluate the possible association with the outcome at 12 months follow-up: demographics (age, gender, BMI), clinical factors (randomly allocated treatment, setting, injury grade, swelling, Ankle Function Score and pain during walking), and work and sport load.

Potential prognostic factors in the group of participants defined as non-recovered at 3 months follow-up were demographic factors (age, gender, BMI), clinical factors (setting, intervention at baseline), and outcome measures at 3 months follow-up (degree of recovery on the numerical rating scale, re-sprains, Ankle Function Score, and pain at rest, walking, and running.)

Linear regression models (for the outcomes recovery and pain during running) and logistic regression models (for the outcomes instability and re-sprains) were constructed for the total population, using the potential prognostic factors from baseline, and separately for the non-recovered participants at 3 months follow-up, using the prognostic factors from the physical examination and the 3-month questionnaire. For

Table 2. Outcomes at 3 and 12 months follow-up of the 102 patients with acute ankle sprain.

Outcome	Baseline	3 months	12 months
Recovery *(0 to 10)*, mean (SD)	–	8.3 (2.0)	8.9 (1.8)
Instability, n (%)	91 (89)	66 (65)	56 (55)
Re-sprains, n (%)	–	24 (24)	29 (28)
Ankle Function Score *(0 to 100)*, mean (SD)	42 (19)	86 (18)	89 (19)
Pain at rest *(0 to 10)*, mean (SD)	1.9 (2.0)	0.4 (1.1)	0.3 (0.8)
Pain during walking *(0 to 10)*, mean (SD)	3.7 (2.8)	0.4 (1.1)	0.2 (0.8)
Pain during running *(0 to 10)*, mean (SD)	7.6 (2.6)	1.6 (2.3)	0.9 (1.7)

Table 3. Univariate regression analyses for recovery, instability, re-sprain, and pain during running at 12 months.

Baseline variable entered in regression models	Recovery (β, 95% CI)	Instability (OR, 95% CI)	Re-sprain (OR, 95% CI)	Pain during running (β, 95% CI)
Age	–0.01 (–0.05 to 0.04)	1.00 (0.97 to 1.04)	0.98 (0.94 to 1.01)	0.02 (–0.04 to 0.08)
Gender (male)	–0.00 (–1.03 to 1.03)	0.80 (0.36 to 1.75)	1.11 (0.44 to 2.80)	–0.06 (–1.46 to 1.35)
BMI	–0.00 (–0.11 to 0.11)	1.03 (0.92 to 1.14)	0.95 (0.84 to 1.08)	0.03 (–0.21 to 0.28)
Randomisation (usual care)	0.08 (–0.82 to 0.97)	1.15 (0.53 to 2.51)	0.89 (0.33 to 2.36)	0.06 (–1.20 to 1.32)
Setting (emergency department)	–0.97 (–4.06 to 2.12)	2.05* (0.89 to 4.71)	1.77 (0.73 to 4.31)	1.16* (–0.30 to 2.62)
Injury grade (moderate or severe)	–0.04 (–1.04 to 0.97)	0.79 (0.38 to 1.63)	0.80 (0.31 to 2.10)	0.34 (–1.03 to 1.72)
Swelling	–0.35 (–2.32 to 1.62)	2.14 (0.48 to 9.58)	0.80 (0.13 to 5.00)	0.04 (–2.89 to 2.98)
Ankle Function Score	0.02* (–0.01 to 0.05)	0.98 (0.95 to 1.01)	0.98 (0.96 to 1.01)	–0.02 (–0.05 to 0.02)
Work load	0.15 (–0.99 to 1.30)	1.49 (0.60 to 3.78)	1.23 (0.43 to 3.56)	0.13 (–1.61 to 1.88)
Sport load	–0.27 (–1.34 to 0.80)	1.25 (0.48 to 3.25)	0.94 (0.30 to 2.92)	0.24 (–1.24 to 1.72)
Pain during walking	–0.13 (–0.38 to 0.12)	1.12 (0.91 to 1.38)	0.57 (0.22 to 1.51)	0.18 (–0.20 to 0.56)

β = beta, CI = Confidence Interval, OR = odds ratio, * = p value < 0.15

the analyses of the physical examination, only data of the participants who underwent the physical examination at 3 months follow-up were included in the analyses.

We tried to adhere to the 'rule of 10' meaning not including more than one variable per event (Peduzzi et al 1996). Therefore, a maximum of 11 baseline variables were included in the analysis for the total population and a total of 12 variables were included for the analyses on the non-recovered participants at 3 months follow-up.

First, a univariate model was constructed for each of the prognostic factors separately. Second, factors with a *p* value ≤ 0.15 on the Wald test in univariate models were entered into backward multivariate selection model. Linear regression models were constructed for the potential prognostic factors at baseline and three months follow-up for the outcome measures recovery and pain during running. Logistic regression models were constructed for the use of baseline and three months variables for the outcome measures instability and re-sprains. The results of each linear regression is presented as a beta (β) with a 95% confidence interval (95% CI) and the result of each logistic regression is presented as an odds ratios (OR) with 95% CI.

Results

Participants

Table 1 presents the patient characteristics and potential prognostic factors of the study population at baseline. Of the 102 participants, 64 (63%) contacted a general practitioner and 38 (37%) an emergency department physician. A total of 49 (48%) participants visited a physical therapist in addition to usual care, and 53 (52%) participants received usual care only. Nine of these participants did not participate in both the 3 month and 12 month follow-up measurements. These nine participants did not differ significantly from participants who completed the 12 month study period regarding their injury grade, re-injuries, and subjective recovery at the earlier follow-up points. The flow of participants through the study is presented in Figure 1.

Table 4. Univariate and multivariate regression analyses for recovery, instability, re-sprain, and pain during running at 12 months follow-up in non-recovered patients at 3 months follow-up (n = 75).

3-month variable entered in regression models	Recovery (β, 95% CI)		Instability (OR, 95% CI)		Re-prain (OR, 95% CI)		Pain during running (β, 95% CI)	
	Univariate	Multivariate	Univariate	Multivariate	Univariate	Multivariate	Univariate	Multivariate
Age	−0.01 (−0.05 to 0.04)	–	0.99 (0.95 to 1.03)	–	0.97 (0.91 to 1.04)	–	0.01 (−0.05 to 0.08)	–
Gender (male)	−0.02 (−1.17 to 1.12)	–	0.78 (0.29 to 2.12)	–	1.18 (0.29 to 4.77)	–	−0.15 (−1.67 to 1.38)	–
BMI	0.00 (−0.13 to 0.14)	–	0.99 (0.87 to 1.13)	–	0.97 (0.81 to 1.15)	–	0.01 (−0.26 to 0.29)	–
Randomisation (usual care)	0.12 (−1.12 to 1.37)	–	0.95 (0.35 to 2.59)	–	0.44 (0.09 to 2.10)	–	0.09 (−1.75 to 1.92)	–
Setting (emergency department)	−0.45 (−1.68 to 0.77)	–	1.90 (0.66 to 5.47)	–	2.69 (0.69 to 10.42)	–	1.21* (−0.22 to 2.64)	–
Recovery	0.33* (0.03 to 0.63)	–	0.34* (0.14 to 0.80)	–	0.97 (0.70 to 1.36)	–	−0.40* (−0.84 to 0.04)	–
Instability	−0.95* (−2.21 to 0.32)	–	16.61* (4.02 to 68.72)	–	2.47 (0.29 to 20.73)	–	1.31 (−0.45 to 3.07)	–
Re-sprain	−0.20* (−2.16 to 1.76)	−1.64 (−3.11 to −0.16)	4.95 (0.52 to 47.47)	–	1.06 (0.12 to 9.13)	–	1.83 (−1.00 to 4.66)	–
Pain (rest)	−0.74* (−1.21 to −0.27)	−0.69 (−1.08 to −0.29)	1.80 (0.76 to 4.26)	–	1.26 (0.81 to 1.96)	–	0.39 (−0.25 to 1.03)	–
Pain (walking)	−0.72* (−1.12 to −0.32)	–	213682109.72 (0 to ∞)	–	1.27 (0.79 to 2.04)	–	0.50 (−0.15 to 1.15)	–
Pain (running)	−0.34* (−0.60 to −0.08)	–	1.72* (1.15 to 2.54)	–	1.12 (0.88 to 1.44)	–	0.35* (0.01 to 0.68)	–
Ankle Function Score	0.04* (0.01 to 0.06)	–	0.95* (0.91 to 0.99)	–	0.99 (0.95 to 1.02)	–	−0.04* (−0.08 to 0.00)	−0.05 (−0.09 to −0.01)

CI = Confidence Interval, β = beta, OR = odds ratio, * = p value < 0.15

Outcomes

Table 2 presents data on recovery, instability, re-sprains, Ankle Function Score, and pain intensity at baseline, 3 months and 12 months. At 3 months, 75% of the participants reported incomplete recovery, and this decreased to 53% at 12 months. At 12 months, 55% of the participants still reported a feeling of instability. In total 24% of the participants reported at least one re-sprain during the first three months compared with 28% during the 12 months of follow-up. About 15% of all participants experienced pain during rest at 3 months follow-up, decreasing to 10% at 12 months. After 12 months, 8% of the participants still experienced pain during walking, while 22% still experienced some pain during running at the 12 month follow-up.

Prognostic factors for outcome at 12 months: The Ankle Function Score (β = 0.024, 95% CI 0.01 to 0.05) was univariately associated with recovery at the 12 month follow-up, but this did not reach statistical significance (Table 3). The setting (emergency department) was univariately associated with both subjective instability and pain during running at 12 month follow-up, with an OR of 2.05 and a β of 1.16, respectively. However, in both analyses, statistical significance was not reached. The occurrence of re-sprains at 12 month follow-up was not univariately associated with any of the 10 possible prognostic factors.

Prognostic factors in non-recovered participants at 3 months follow-up: A total of 75 participants (74%) regarded themselves as not being recovered at 3 months follow-up. Of these 75 participants, 63 (84%) underwent the physical examination at 3 months follow-up and were included in the analysis. Seven of the potential prognostic factors were univariately associated with the outcome recovery at 12 months. The final model (Table 4) included the variables having re-sprains during 3 months of follow-up (β = –1.64, 95% CI –3.11 to –0.16) and having pain at rest at 3 months of follow-up (β = –0.69, 95% CI –1.08 to –0.29). Re-sprains at the 12 month follow-up were not univariately associated with any of the potential prognostic factors at 3 months follow-up.

Subjective instability at the 12 month follow-up was univariately associated with four potential prognostic factors (pain during running, Ankle Function Score, recovery, and instability at 3-months follow-up). After backward selection, the final multivariate model included pain during running (OR = 1.48, 95% CI 0.99 to 2.23) and instability (OR = 6.89, 95% CI 0.30 to 159.17) at 3 months of follow-up. However, these factors did not reach significance.

Pain during running at the 12 month follow-up was univariately associated with four potential prognostic factors (setting, pain during running, Ankle Function Score, and recovery at 3 months follow-up). The Ankle Function Score at 3 months follow-up (β = –0.05, 95% CI –0.09 to –0.01) and setting (β = 1.11, 95% CI –0.53 to 2.76) were included in the final multivariate model. However, only the Ankle Function Score was significantly associated with pain during running at the 12 month follow-up (β = –0.05, 95% CI –0.09 to –0.01).

The participants who did not attend the physical examination were on average younger (36.5 vs 34.8 years), had a higher BMI (25.5 vs 26.5), and were more often treated with physical therapy (40% vs 70%) than those who attended. There was no univariate association between any of the five possible prognostic factors from the 3 month follow-up and subjective recovery at the 12 month follow-up. Pain during running and the occurrence of re-sprains were both univariately, but not significantly, associated with the pressure threshold of the ventral malleoli lateralis. Finally, reported instability at the 12 month follow-up was univariately associated with the pressure thresholds of the ventral, distal, and dorsal malleoli lateralis. The final multivariate model included the pressure thresholds of the ventral (OR = 2.03, 95% CI 0.99 to 4.15) and dorsal malleoli lateralis (OR = 4.26, 95% CI 1.14 to 15.96); only the association with the dorsal malleoli lateralis was significant ($p = 0.035$).

Discussion

In this study, 51% of the participants with lateral ankle sprains were not fully recovered after 12 months of follow-up. The regression analyses of possible prognostic factors at baseline for persistent complaints could not identify a strong predictor for the outcome at the 12 month follow-up. The analyses for the prognosis in the subgroup of non-recovered participants at 3 months follow-up showed that factors from the 3 month questionnaire can better predict the outcome than the factors from the physical examination at 3 months.

At 12 months, 28% of the participants reported at least one re-sprain, which is in line with earlier studies reporting that 29% (Holme et al 1999) and 54% (Wester et al 1996) of the participants receiving usual care sustained a re-sprain at approximately 12 months follow-up. In our study, 49% of the participants were regarded as recovered at 12 months. This is comparable with the outcome of a recent systematic review showing that 36% to 85% of the patients reported full recovery at 2 weeks to 36 months follow-up after ankle sprain injuries (van Rijn et al 2008). The wide recovery range found in the different studies could be related to the definition of recovery. A widely used and accepted definition of recovery would therefore be very useful for future studies. Several studies investigated pain after a lateral ankle sprain (Moller-Larsen et al 1988, Nilsson 1983, O'Hara et al 1992). The proportion of patients experiencing pain after at least 12 months ranged from 5% to 33% (van Rijn et al 2008). Our study results are similar to these findings, but only 8% of our participants reported pain during walking while 22% still experienced some pain during running at 12 months.

We did not find prognostic factors at baseline for the prediction of outcome at 12 months of follow-up. None of the 11 possible prognostic factors was univariately associated with any of the outcome measures. The fact that we did not find any significant association could be related to the small number of participants included in the analyses. Further, it might be possible that there are other prognostic factors, not included in our analyses, which can predict the outcome at 12 months follow-up. To our knowledge, the study from Linde and colleagues (1986) is the only study evaluating prognostic factors for incomplete recovery and re-sprains. In this study, sporting activity at a high level (training ≥ 3 times per week) was a significant prognostic factor for residual symptoms compared with sporting activity at a low level (training < 3 times per week) and no sporting activity. Unfortunately, our questionnaire did not include detailed

questions about the sporting activities of the participants. However, we did ask the participants if the ankle was loaded during their sporting activities, and this factor does not appear to have a positive or negative influence on recovery, re-sprains, or pain among our participants.

Because there might be factors during the 12 month follow-up period that can predict the outcome at 12 months, we analysed the 3 month data with respect to subjective and objective prognostic factors. These analyses showed that a low Ankle Function Score at 3 months predicts a high score on pain during running at 12 months of follow-up. Further, we found a positive association between re-sprains during the first 3 months of follow-up and subjective recovery at 12 months. About 24% of the participants incurred a re-sprain during the first 3 months of follow-up. Of these, 37% regarded themselves recovered at 12 months. Additionally, only 30% of the participants with a re-sprain during the 12 months follow-up regarded themselves recovered at 12 months follow-up. Therefore, it seems that the occurrence of a re-sprain predicts the subjective feeling of recovery. Because of this suggestion, we tested *post hoc* the association between re-sprains that occurred between month 3 and 12 and recovery at 12 months follow-up, in both the total study population and in the non-recovered participants at 3 months follow-up. These analyses showed a strong significant association between re-sprains and recovery for the total population ($\beta = 3.12$, 95% CI –4.86 to –1.37) and for the non-recovered participants at 3 months ($\beta = –2.97$, 95% CI –4.43 to –1.51). Therefore, studies focusing on the prevention of re-sprains after an ankle sprain might interfere in this relationship and could have a positive effect on subjective recovery of ankle sprain patients (Hupperets et al 2009).

The physical examination at 3 months follow-up does not appear to have an additional value in the prediction of recovery at 12 months. Only one factor from the physical examination at 3 months follow-up could predict the outcome at the 12 month follow-up; the pressure threshold on the dorsal malleoli lateralis was positively associated with subjective instability of the ankle at 12 months. The fact that we found so few associations with any of the factors from the physical examination could be related to the small number of patients included in the analysis. Furthermore, we did not have extensive data from the physical examination and could therefore only include five possible prognostic factors in the analyses. However, from the available data, we have to conclude that the physical examination we performed at the 3 month follow-up does not have additional value for the prediction of the outcome at 12 months.

Our sample of participants was studied prospectively and could be considered as a cohort of patients with acute ankle sprains in which the interventions were regarded as potential prognostic factors. The interventions studied in the randomised trial were strictly protocolised, which resulted in less treatment heterogeneity than in most other population-based cohort studies. Physical therapy treatment was considered to be a prognostic factor, but no significant treatment effect was found (van Rijn et al 2007). Because the data used in this study were derived from a randomised trial investigating the effectiveness of supervised exercise in primary care, some selection bias of patients might have occurred. Also, a selection bias might have occurred in the patient group who underwent the physical examination compared to the total study population.

Both the possible prognostic factors from the baseline questionnaire and the outcomes are self-reported and therefore subjective. However, since there are no validated objective outcome measures available for patients with acute lateral ankle sprains, the use of validated subjective outcome measures seems appropriate. Nevertheless, some factors and outcomes may not be completely reliable because of the subjective nature.

Because of the relatively small number of participants included in the original randomised trial, we were not able to completely adhere to 'the rule of 10' and we were not able to evaluate more possible prognostic factors. For example, we did not include the variable 'earlier injury more than 2 years ago' in our analyses, which might have been of interest. Additionally, because this study was not primarily designed to evaluate prognostic factors, we could have missed some factors. In military populations, decreased dorsiflexion was shown to be a risk factor for ankle sprains and might also play an important prognostic role (Milgrom et al 1991). Additionally, recent systematic reviews suggest that ankle strength might be an important predictor for re-sprains (Arnold et al 2009a, Arnold et al 2009b, Hiller et al 2011). It might be useful to evaluate these factors in future studies. The final model could have been overfitted because of the number of participants in our 3 month analyses and the number of possible prognostic factors included in the model.

From this study we know that re-sprains sustained during the first 3 months after the initial sprain, and pain at rest at 3 months follow-up are related to incomplete recovery after 12 months. Additional literature from Linde and colleagues (1986) found that sporting activity at a high level is a prognostic factor for residual symptoms compared to sporting activity at a low level or no sport. A general practitioner or physical therapist should take these factors into account when advising a patient about treatment options and possible preventive measures. More active people can be advised to support their ankle with semi-rigid braces during high-risk activities or to undertake proprioceptive training, as there is evidence that this can prevent sprains especially in patients with previous ankle sprains (Handoll et al 2001, Hupperets et al 2009).

In conclusion, among patients reporting persistent complaints 3 months after an ankle sprain, 51% still report persistent complaints at 12 months follow-up. Unfortunately, we could not find many clear predictive factors from the 3 month evaluation for the outcome at 12 months. Only re-sprains and pain at rest can predict a negative recovery outcome at 12 months. Therefore, we have to conclude that more research is needed to evaluate prognostic factors for poor recovery, re-sprains, and residual pain. Possibly, the prognosis could by improved by additional diagnostics, such as magnetic resonance imaging and radiography. A large cohort study may be helpful to identify patients at risk and to evaluate the consequences of these persistent complaints. ■

Footnotes: [a]Cybex EDI 320, New York, USA.

eAddenda: Appendix 1 available at jop.physiotherapy.asn.au

Ethics: The Medical Ethics Committee of the Erasmus Medical Center in Rotterdam (196.926/2000/238) approved this study. All participants gave written informed consent before data collection began.

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