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Research Article

Incidence and Determinants of Recurrent Lateral Ankle Ligamentous Sprain

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Abstract

Objective: Little is known about the incidence and determinants of recurrent acute lateral ankle ligamentous sprain (ALALS) in the general population. Our purpose was to determine the proportion of patients suffering from recurrent ALALS during one year follow-up after the initial injury and to identify risk factors for sustaining a recurrent ALALS.

Design: Prospective cohort study.

Setting: Patients were recruited from 20 family practices, nine physical therapy practices and emergency departments of two hospitals.

Subjects: Adult patients with an ALALS caused by inversion trauma.

Methods: Univariable and multivariable Cox regression analysis.

Results: After 52 weeks follow-up, 29 of the 157 patients (18%; 95% CI 12.4-24.5) had experienced an ALALS. Univariable analysis showed that younger age, a lower BMI, having had more than one ankle injury, sports participation and the number of hours of sports per week was associated with the risk of recurrent ALALS. Multivariable analysis showed that with increasing age the risk to suffer an ALALS decreases (HR 0.92 (95% CI 0.87-0.98).

Conclusions: Nearly one fifth of the patients with ALALS suffer from a re-injury within 12 months and the injury risk decreases with increasing age. This highlights the importance of optimal treatment and preventive programs in younger adults.

Keywords: Ankle sprain; Re-injuries; Risk factors; Prognosis; Prevention

Abbreviations

ALALS: Acute Lateral Anke Sprains; HR: Hazard Ratio; OR: Odds Ratio; CI: Confidence Interval; BMI: Body Mass Index; UMC: University Medical Center; ICE: Immobilization, Compression and Elevation; NSAIDs: Non-Steroidal Anti-Inflammatory Drugs; SD: Standard Deviation; h: Hours; N: Number; β: β-coefficient; SE: Standard error of the Estimate

Introduction

After the knee, the ankle is the most injured body site in athletes (11% to 21%) [1]. Depending on the population studied, ankle sprains account for by to of all ankle injuries in athletes [1]. Reported incidence rates for ankle sprains in the general population vary from 1.5 up to almost 7 per 1,000 person-years [2-5]. Most ankle sprains (85%) are located on the lateral side [6].

The consequences of acute lateral ankle ligamentous sprains (ALALS) can sustain over a long period of time. One of the most important long-term consequences is recurrent ALALS, although studies reporting on the incidence of recurrent sprains tend to report large differences. A systematic review by van Rijn et al. (2008) showed that 3 to 34% of the patients suffer a recurrent ALALS of the injured ankle within 3 years [7]. The highest rates of recurrent lateral ankle sprains are reported among athletes, mainly active in team sports [8,9]. The mean time to return to sports after a recurrent sprain seems to be higher than after a first-time ankle sprain [10]. A recurrent ALALS causes longer absence of players in team sports [10] and causes additional work absenteeism in the general population [11].

From earlier research it is known that a previous lateral ankle sprain in an athlete's history is one of the most important risk factors for sustaining an ankle sprain [12,13]. It is useful to identify people who is increased risk of sustaining a recurrent sprain, because the occurrence of a recurrent sprain has a large impact on a patient's daily functioning and sports participation. In addition, information about risk factors for recurrences yields important input for targeted preventive strategies.

Two earlier studies identified risk factors for a recurrent ALALS. Pre-injury activity level [14] and grade of initial injury [10] were significant predictors of recurrent ALALS. However, one study [14] included only athletes and neither of these studies performed multivariable analysis and thus did not identify independent predictors.

The purposes of this study were to determine the proportion of patients (athletes and non-athletes) that suffer one or more recurrent ALALS during the first year after the initial injury and to identify determinants of sustaining a recurrent ALALS.

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Table 1: Baseline characteristics of all patients with an acute lateral ankle ligamentous sprain (n=157).

Male gender (%)	88 (56.1 %)
Mean age (SD) in years	31.1 (11.6)
Mean BMI (SD) * in years	24.5 (4.3)
History of ankle injury (%)	
- One ankle injury (initial injury of the study)	99 (63.1 %)
- More than one ankle injury	58 (36.9 %)
Respondents who had an ankle injury within one year prior to the start of the study (%)	10 (6.4 %)
Sports participation# (%)	132 (84.1 %)
Mean hours of sports participation (SD)	4.4 (3.7)
Severity of initial injury (%)	
- Mild	45 (28.7 %)
- Moderate	86 (54.8 %)
- Severe	26 (16.6 %)
Treatment (%)	
- Brace	77 (49.0 %)
- Tape	80 (51.0 %)

N = number, *N= 156, #Number of ankle injuries includes initial injury of the study, SD = Standard deviation # Participating in sports in the week prior to the occurrence of the initial injury.

Methods

Study design

This prospective cohort study was part of a controlled trial on treatment of acute lateral ankle ligamentous sprains [15]. Between May 2006 and October 2008, 164 patients were recruited for this pragmatic multi-center trial of which 157 were eligible for inclusion. Patients were randomly allocated to 4-week functional treatment with either a soft ankle brace or ankle tape. The protocol for this study was approved by the medical ethics committee of the University Medical Center (UMC) Utrecht. All patients included gave their written informed consent. The results of the trial showed no significant differences between the two treatment groups [15]. Based on this conclusion, both study groups were combined to one cohort of patients for the present study.

Participants

Patients were recruited from 20 general practitioner practices, nine physical therapy practices (region of Utrecht, the Netherlands) and the emergency departments of two hospitals, namely Zuwe Hofpoort hospital in Woerden and the UMC Utrecht, both in the Netherlands. All included patients suffered an ALALS due to an inversion trauma within 14 days previous to inclusion. Patients were excluded if they were younger than 18 years, if they suffered an eversion trauma, multiple trauma or complicated trauma (including cartilage injuries and dislocation), or had a history of ankle surgery. Patients with documented mental illness or cognitive impairment were also excluded from this study.

Procedure

All patients were treated according to the ICE-protocol (Immobilization, Compression and Elevation) during the acute period. Functional treatment (tape or brace) started as soon as possible but at least within 14 days after the initial trauma. At initial treatment, no specific pain medication protocol was prescribed; patients were allowed to take pain medication, including non-steroidal anti-inflammatory drugs (NSAIDs) at their own convenience. Baseline measurements of all patients were obtained in a standardized manner by a sports physician. Participants were asked to fill out online questionnaires at 5, 9, 13, 26 and 39 weeks after the initial ankle sprain. In week 52, a final questionnaire was combined with a physical re-examination by a sports physician.

Outcome variable

The outcome variable, recurrent ALALS, was defined as an inversion trauma of the same ankle affected at baseline [15]. Other injury types (e.g. strain, fracture, and overload) were not classified as ALALS. Information on the outcome variable was obtained from the self-reported online questionnaires during the follow-up period and the final questionnaire administered at 52 weeks.

Determinants of recurrence

The following potential determinants were measured: gender, age, body mass index (BMI), the number of ankle injuries in the patients' history, having had an ankle injury within one year prior to the start of the study, sports participation, the severity of the initial ankle sprain and the allocated treatment.

To gain more insight into the age distribution, age was divided into quartiles. BMI was calculated as weight/ length^2 (kg/m2) and divided into normal weight (≤ 25) and overweight (>25). The number of ankle injuries in a patients' history included the initial injury from this study and was dichotomized in one and more than one. Sports participation at baseline was reported as yes or no and in mean number of hours of sports participation per week. The hours of sports participation were also divided into quartiles. No definition of sports was given in advance. The severity of the ankle sprain at baseline was classified into three categories: mild, moderate or severe. The severity score was based on data from the physical examination at baseline, corrected for the number of days between the physical examination and the initial inversion trauma (see Appendix A).

Table 2: Incidences of a recurrent acute lateral ankle ligamentous sprains during 1 year follow-up.

	Proportion of patients with ALALS	P-value
Sex		
Males	21.6	0.303
Females	14.5	
Age (quartiles)		
18 < 21.5 years	30.8	<0.001
to 27 years	33.3	
27 to 38 years	9.5	
> 38 years	2.5	
BMI		
Normal weight	19.4	0.46
Overweight	12.2	
History of ankle injury		
One ankle injury (initial injury)	14.1	0.088
More than one ankle injury	25.9	
Having had an ankle injury one year prior to study		
Yes	20.1	1
No	18.4	
Sports participation		
Yes	21.2	0.048#
No	4	
Hours of sports participation per week (quartiles)		
0 < 2.25	5.1	0.007
2.25 to 4.00	15.4	
4.00 to 5.50	17.1	
> 5.5	34.1	
Severity initial injury		
Mild	24.4	0.471
Moderate	16.3	
Severe	15.4	
Treatment		
Brace	18.2	1
Tape	18.8	

#1 cells (25,0%) have expected count less than 5. The minimum expected count is 4,62.
ALALS = acute lateral ankle ligamentous sprain.
N = number.
H = hours.
SD = Standard deviation.

Statistical analysis

Baseline characteristics were described using mean with standard deviation (SD), range or frequencies, where appropriate. The 1-year incidence of a recurrent acute lateral ankle ligamentous sprains were compared for categories of the potential determinants using Chi-square or (for dichotomous variables) Fisher-exact test. In this analysis, age and hours of sports were into quartiles and BMI was dichotomized (normal weight ≤ 25 kg/m^2 and overweight > 25 kg/m^2.

Multiple imputation was used to assess missing data (n=18) for ankle sprain recurrences. Sensitivity analyses were performed with complete cases only (n=139).

The association between each determinant and the occurrence of a recurrent sprain was examined using univariable Cox regression analysis. All variables were tested for the proportional hazards assumption. If the interaction term between the variable and the natural logarithm of time was not significant (p>0.05), the proportional hazards assumption was considered being met [16]. Variables with a p-level of <0.1 in the univariable analysis, showing no multicollinearity, were included in a multivariate Cox regression analysis. The p-level of 0.1 was chosen liberally to avoid that possible predictors were missed in the multivariable analysis. Multicollinearity was tested by obtaining variance inflation factors (VIF) and tolerance values, a VIF value <10 and a tolerance value >0.1 was interpreted as no indication for multicollinearity [17]. All data were analyzed using IBM SPSS Statistical software package (version 23.0).

Results

In total, 157 patients were included in the trial. The baseline characteristics of the study population are presented in Table 1. Patients had a mean age of 31 years (SD 11.6), a mean BMI of 24.5 kg/m^2 (SD 4.27) and 88 participants (56%) were male. Participants in this study had to fill out six questionnaires during the 1-year follow-up period. For 11% of the participants (n = 18) data were not complete at the end of the clinical trial. Nine participants did not fill out the last questionnaire, one participant missed three measurements, another one missed four measurements and one participant did not fill out five questionnaires. Six participants did not fill out any questionnaire.

For 63% of the included patients, the initial ankle sprain was their first time ankle injury, 37% had two or more ankle injuries. Ten patients (6.4%) had an ankle injury within one year prior to the start of this study. Most ALALS at baseline (55%) were of moderate severity. The majority of the patients (84%) were sports participants, reporting a mean duration of sports participation of 4.4 (SD 3.7) hours per week.

After 52 weeks follow-up, 29 patients (18%: 95% CI 12.4-24.5) experienced at least one recurrent ALALS. Two patients suffered two recurrent ALALS and two more patients suffered three recurrences, thus in total 35 recurrent ALALS were reported.

The proportion of patients with a recurrent ALALS was higher among athletes compared to non-athletes (21.2% vs. 4.0%; p = 0.048) and this proportion increased with an increasing hours of sports participation per week. Furthermore, the proportion of patients with a recurrent ALALS is higher amongst those aged 18 < 27 (p<0.000).

For all variables, the proportional hazards assumption was met. Univariable analysis showed associations (p<0.10) between a recurrent ALALS and a younger age, a lower BMI, a history of more than one ankle injury (including the initial injury of this study), sports participation and a higher number of hours of sports per week (Table 2). In the multivariable Cox regression analysis only a younger age (HR 0.92 per year, 95%CI 0.87-0.98) was an independent predictor of recurrent ALALS within 52 weeks (Table 3).

In a sensitivity analyses with only 139 complete cases included,

Table 3: Univariable and multivariable Cox regression analyses of potential predictors for a recurrent lateral ankle ligamentous sprain.

	Univariable analysis			Multivariable analysis		
Independent Variables	**β**	**SE**	**HR (95% CI)**	**β**	**SE**	**HR (95% CI)**
Gender (male)	0.37	0.39	1.45 (0.68-3.12)			
Age *	-0.11	0.03	0.90 (0.85-0.95)	-0.08	0.03	0.92 (0.87-0.98)
BMI *	-0.14	0.06	0.87 (0.77-0.99)	-0.06	0.07	0.94 (0.83-1.07)
More than one ankle injury in history *	0.69	0.37	1.98 (0.96-4.11)	0.43	0.38	1.54 (0.74-3.21)
Ankle injury one year prior to study	-0.02	0.73	0.98 (0.23-4.11)			
Sports participation (yes) *	1.65	1.02	5.20 (0.71-38.22)	-0.45	1.09	0.64 (0.08-5.36)
Sports participation (hours/week) *	0.09	0.04	1.08 (1.00-1.17)	0.07	0.06	1.07 (0.96-1.19)
Severity initial injury						
- Mild			Reference category			
- Moderate	-0.52	0.4	0.59 (0.27-1.31)			
- Severe	-0.59	0.58	0.55 (0.18-1.74)			
Treatment (brace)	-0.08	0.37	0.92 (0.44-1.91)			

BMI = body mass index, HR = Hazard Ratio, β = β-coefficient, SE = standard error of the estimate
*Predictors ($p<0.1$) for a recurrent sprain in univariate analysis.

univariable analysis showed associations ($p<0.10$) between a recurrent ALALS and a younger age and a history of more than one ankle injury (including the initial injury of this study). In the multivariable Cox regression analysis only a younger age was an independent predictor of a recurrent ALALS (HR 0.91 per year (95% CI 0.86-0.97).

Discussion

Of all participants, 18% experienced a recurrent ALALS within one year after the initial ankle sprain. The frequency of recurrent sprains in this study is in line with the findings from earlier studies, where 1-year incidences ranging from with to were reported [14,18-23]. Van Rijn et al. (2008) found in their systematic review that 3-34% of the patients with an ALALS suffer a recurrent sprain within 3 years and that 15-64% does not fully recover from their ankle sprain within this period [7]. This confirms the current idea that a seemingly innocent injury, such as a lateral ankle ligamentous sprain, can have long-term consequences such as pain and subjective instability for a patient [6].

Age was the only independent predictor of ALALS recurrence in our study. The risk to suffer a recurrent ALALS is highest in young adults. A sensitivity analysis restricted to complete cases showed similar results. Braun (1999) also found recurrent sprains mainly to be reported by younger patients [8]. Perhaps the reason for this result is a certain rashness of young people when participating in sports and other physical activities. Another explanation might be that a greater portion of young people participate in competitive sports, involving pivoting and jumping. In team sports and court games, ankle sprains are most common [1]. In our study, 132 patients were active in sports in the week prior to the occurrence of the initial injury and 78 of the sports participants were active in competitive sports like soccer, basketball, volleyball, tennis and korfball. The association, between being engaged in sports and ankle sprains recurrences we observed in the univariable analysis was statistically significant, but not very strong. Earlier research by Haraguchi et al. (2009) and Linde et al. (1986) also showed that patients with a higher level of physical activity are more prone to suffer a recurrent ALALS. Interestingly, the association with sports participation disappeared in our multivariable analysis, including other determinants and in particular age. It is important to keep in mind, however, that the information about sports participation might not be detailed enough to fully elucidate the role of sporting activities on the incidence of recurrent ALALS.

Having a history of ankle injury is a well-known risk factor for sustaining a new lateral ankle sprain in general [13,24-26]. Earlier research of Engebretsen et al. (2010) showed that the number of acute ankle injuries in the past is positively correlated with the risk for a new acute ankle injury. This seems to be in line with our univariable results, where we dichotomized the number of ankle injuries in one and more than one. The number of patients with three of four ankle injuries in the past was too small to estimate the recurrence risk in these patients.

In our univariable analysis, the present study showed a significant association between a lower BMI and a recurrent sprain. Our finding is in contrast to an earlier study of Timm et al. (2005) who found a positive, but non-statistically significant, association between a higher BMI and a recurrent ankle sprain in obese children [27]. The role of BMI as a risk factor for ankle sprains in general, both first and recurrent sprain, remains unclear [13,26,28].

In contrast to Malliaropoulos et al. (2009), who found a mild/moderate lateral ankle sprain (grade I and II) to be a prognostic factor for a recurrent sprain, we found no relationship between severity and recurrence.

Although the proportion of recurrent ALALS in this study is in line with earlier reported studies [13,14,19-23], a limitation of our study is the lack of power to assess the role of multiple determinants. Risk factors with a small to moderate association might not be identified through this study due to the small number of recurrent ALALS cases [29]. Moreover, considering the 1:10 'rule', i.e. per variable considered as predictors of recurrent ALALS one should

have 10 patients with the outcome (recurrent ALALS), we had to be very restrictive in the number of variables we included in the analyses.

Hyper flexibility (and prior subluxation of other joints), might be a determinant of recurrence of ankle sprains. However, as this study was part of a controlled trial on the treatment of acute lateral ligamentous ankle sprains, information about hyper flexibility was not our primary goal and therefore not systematically assessed. A post-hoc analysis showed that the Talar tilt and drawer sign of the heterolateral ankle (possible signs of hyper flexibility) were not univariably associated with recurrence.

Identification of risk factors for recurrent ALALS is important, because more insight in these risk factors can underline the importance of preventing recurrent ankle sprains. When patients with a higher risk for a recurrent sprain could be identified adequately, tailored advice about the best prevention programs could be given. Fortunately, several effective ankle injury preventive measures are known and most of these are very easy to apply. First of all both ankle tape and ankle braces can be used in the prevention of ankle sprain recurrences [31]. Also, proprioceptive training programs, training coordination and balance, can prevent ankle sprain recurrences [30,31]. The injury preventive measure taken should depend on the preferences of the patients to increase the adherence to the preventive intervention. Our study highlights the importance of optimal treatment and preventive programs in young adults, to reduce the burden from recurrent lateral ankle ligamentous sprains. More research is needed to clarify the relationship between BMI and the risk for ankle sprain recurrences [32, 33].

Conclusion

In this study, nearly one fifth of the patients with ALALS suffered from a re-injury within 12 months and the injury risk decreases with increasing age. This highlights the importance of optimal treatment and preventive programs in younger adults.

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