Delayed Exercise Therapy after acute Ankle Sprain Increases Functional Ankle Instability – The Later, the Worse: A Retrospective Analysis.

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Research

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Abstract

Background:

The lateral ankle sprain (LAS) is one of the most common injuries in everyday life and sports. Approximately 20-40% of patients with a LAS develop a chronic ankle instability (CAI). The underlying mechanisms for CAI have not yet been clearly clarified. An inadequate rehabilitation after LAS can be speculated, since the LAS is often handled as a minor injury demanding less treatment Therefore, the aim of this retrospective study was to first determine the CAI rate depending on age and sex and second, to identify possible risk factors for developing CAI.

Methods:

Between 2015 and 2018 we applied the diagnostic code “sprain of ankle” (ICD S93.4) to identify relevant cases from the database of the BG Klinikum Duisburg, Germany. Patients received a questionnaire containing the Tegner-Score as well as the patient-related outcome measures including the Cumberland Ankle Instability Tool (CAIT) and the Foot and Ankle Disability Index. Additionally, there were questions about the cause of accident, time points of therapy onset, as well as the number of recurrent sprains. There was a total of 647 completed datasets which were separated into a CAI and a COPPER group according to a CAIT cut-off score of <24.

Results:

The overall CAI rate was 17.3%. We identified a higher risk for CAI in females and within the age segment of 41 to 55 years. A later therapy onset (>4 weeks) after acute LAS significantly worsens ankle function in CAIT (p<.05). There was a significantly higher CAIT score in patients having no recurrent sprain compared to patients having 1-3 recurrent sprains (p<.001) or 3-5 recurrent sprains (p<.001).

Conclusion:

Females and older age groups have a higher risk for developing CAI which implies to perform specific prevention programs improving ankle function following LAS. A delayed onset of exercise therapy seems to be an important risk factor for the development of CAI. A further risk factor, suggested by literature, is the number of recurrent sprains that could be also confirmed by our data. Therefore, we recommend an early onset of functional exercise therapy after acute LAS in the future to minimize the development of CAI.

Background

The lateral ankle sprain (LAS) is one of the most common musculoskeletal injuries in everyday life and sports (1, 2). In the western states one ankle sprain occurs per 10,000 residents daily (3). In sports, there is an incidence rate of 0.93/1000 athlete-exposures with one athlete participating in one competition or
training being an athlete-exposure (4). The rate of recurrent ankle sprains is high which is proved to be a risk factor for the development of a chronic ankle instability (CAI) (5).

Approximately 20–40% of patients with a LAS will develop a CAI which is characterized as a continuum of mechanical and/or functional instability resulting in subjective instability, recurrent sprains and persistent pain (6–8). The medical treatment, work loss as well as a loss of productivity lead to high socioeconomic costs, especially with recurrent sprains and long-term problems (2). Epidemiological studies have shown that the total costs of a LAS in the European union range between 800 € and 1100 € (2). In the Netherlands, productivity loss due to absence from work was responsible for up to 80% of their total costs of a LAS (9). In 2019, there were 60,000 LAS in Germany leading to a total of 550,000 lost workdays (on request at the DGUV from 13.08.2020; DGUV, German Statutory Accident Assurance) Thus, it seems that the current treatment concepts after having a LAS are not sufficient to adequately restore ankle function and stability.

A possible explanation for the high instability rate is an insufficient rehabilitation and/or a too early return to intense sports and workloads (10). Up to now the LAS is still handled as a minor injury that will resolve quickly with limited treatment although the first LAS is often the start point for severe and long-lasting symptoms (11, 12). In addition, there is currently no standardized evidence-based rehabilitation concept for LAS that effectively reduces the CAI rate. There are only some general treatment recommendations in literature (7, 13). In patients with CAI, Miklovic et al. (2018) identified four impairments domains (range of motion, strength, proprioception, functional tasks) that were likely not adequately treated after the primary LAS. Consequently, the authors recommend considering these functional deficits already at an early stage during rehabilitation after an acute LAS to prevent persistent or even chronic symptoms (13). This concept has not been empirically evaluated, yet.

Therefore, the aim of this four-year retrospective study is twofold in order to get a better understanding of LAS from an epidemiological perspective. First, we want to determine the CAI rate depending on age and sex and to compare it with the current empirical database. Second, we want to identify possible explanations or risk factors for developing CAI and long-term consequences. Both are relevant goals to possibly derive and evaluate novel treatment strategies after incurring a LAS.

**Methods**

**Study design**

A retrospective study design was used (Fig. 1). Between 2015 and 2018 we applied the diagnostic code “sprain of ankle” (ICD S93.4) to identify relevant cases from the database of the BG Klinikum Duisburg, Germany. Participants between the ages of 14 to 55 years were included. Valid ankle sprains were defined as acute ankle sprains with no accompanying bone injuries. Cases that did not meet these criteria were excluded. The used criteria were selected due to the recommendations of the International Ankle Consortium (14). A total of 1478 matching cases were detected.
All patients of the identified cases received a postal questionnaire containing the Tegner-Score as well as the patient-related outcome measures (PROMs) including the Cumberland Ankle Instability Tool (CAIT) and the Foot and Ankle Disability Index (FADI). Additionally, there were questions about the cause of accident, time points of therapy onset (immediate start, 1-4 weeks, >4 weeks or no received therapy), as well as the number of recurrent sprains (no recurrent sprains, 1-3x, 3-5x). The Tegner-Score contains different grades of activity, developed for patients. Its values range from zero to ten, with zero representing being bedridden and ten representing doing competitive sport at a professional level (15). CAIT and FADI are validated questionnaires to get a subjective insight into regional functional impairments following a LAS. The CAIT consists of 9 items measuring the severity of functional ankle instability during the performance of different activities or tasks. The total score ranges from 0 to 30. Furthermore, the CAIT is used as a tool to differentiate between copers and non-copers of CAI by using a cut-off score of <24 points (14). The FADI assesses functional limitations, consisting of 26 items with the possibility to rate the grade of limitation. It is reported as a percentage of the highest possible score (16, 17). Due to the low number of valid questionnaires received, an additional phone interview was performed. Because of economic reasons, the phone interview included only the PROMS, CAIT and FADI.

Participants

The received PROMS (n=198) and performed phone interviews (n=449) led to a total of 647 completed datasets. The sample consisted of 381 male and 266 female participants. Participants were divided into three age groups (14 to 25, 26 to 40 and 41 to 55). Furthermore, they were separated into a CAI and a COPER group according to a CAIT cut-off score of <24. Sample characteristics according to their level of activity can be seen in Tab. 1. The study was approved by the local ethics committee (Ärztekammer Nordrhein, 2018363) and was conducted in accordance with the Declaration of Helsinki. All participants provided written informed consent.
Table 1
Levels of activity separated by age groups.

| Age group  | Tegner-Score | Corresponding level of activity                                      |
|------------|--------------|---------------------------------------------------------------------|
| All        | 6            | Recreational sport: tennis, badminton handball                       |
| 14-25 years| 7            | Competitive sport: Tennis, track and field, handball                |
|            |              | Recreational sport: soccer                                         |
| 26-40 years| 5            | Heavy physical work                                                 |
|            |              | Competitive sport: cycling                                          |
|            |              | Jogging on uneven terrain                                           |
| 41-55 years| 4            | Medium heavy physical work                                          |
|            |              | Recreational sport: cycling                                          |
|            |              | Jogging on even terrain                                             |

Statistics

Descriptive statistics using frequency analysis were performed to calculate the percentage CAI rate. Since the FADI was not normally distributed, according to the Shapiro Wilk test (p<.05), the Mann Whitney U test was performed to assess differences between the CAI and COPER groups in the FADI. Differences in therapy onsets between CAI and COPER groups were also performed via frequency analysis. A one-way ANOVA was used to determine the effects of time point of therapy onset on the CAIT score and to assess the effects of number of recurrent sprains on the CAIT score. The Tukey post-hoc test was used for pairwise comparisons. Homogeneity of variance was verified with the Levene’s test (p >.05). In case homogeneity of variance was violated, a Welch ANOVA using Games-Howell post-hoc analysis was applied. Statistical analysis was done using SPSS Statistics (IBM, Armonk, New York, USA, Version 23.0).

Results

The overall CAI rate was 17.3%. Males were consistently less affected than females over all age groups. The highest CAI rate with 22.7% was found in the 41-55 years age group (Tab. 2). The total FADI score significantly differed between CAI and COPER groups, (79.0 vs. 97.1 %; U = 3674.00, Z = -2.237, p < .05).
Table 2
Absolute CAI rate and its relative sex distribution in different age groups.

|           | CAI rate (%) | Male (%) of CAI rate | Female (%) of CAI rate |
|-----------|--------------|----------------------|------------------------|
| all       | 17.3         | 41.4                 | 58.6                   |
| 14-25 years | 11.7        | 38.7                 | 61.3                   |
| 26-40 years | 12.4        | 47.6                 | 52.4                   |
| 41-55 years | 22.7        | 40                   | 60                     |

Sport and everyday life were the two main reasons for incurring a LAS, while the job was chosen by 12% (Fig. 2).

For most of the sample, the therapy started one to four weeks after the initial injury (Fig. 3). The lowest proportion received it immediately. A higher percentage of COPER started their therapy immediately and after 1-4 weeks while there was a higher percentage of CAI starting their therapy after more than 4 weeks or receiving no therapy (Fig. 3). The mean CAIT decreased with a later timepoint of therapy onset: immediately start (23.35 ± 6.93), 1-4 weeks (20.02 ± 8.46), >4 weeks (16.43 ± 9.01), no received therapy (18.20 ± 8.05). The CAIT significantly differed among the timepoints of therapy onsets (F(3,145) = 3.34, p<.05). Tukey post-hoc analysis revealed a significant difference between an immediately start and >4 weeks after the initial LAS (p<.05) (Fig. 3).

The CAIT significantly differed in the reported frequency categories (no recurrent sprains 28.35 ± 4.71, 1-3x 18.62 ± 6.87 and 3-5x 16 ± 5.53), F(2,562) = 81.379, p < .001. Games-Howell post-hoc analysis revealed a significant difference between having no recurrent sprain and having 1-3 recurrent sprains as well as between having no recurrent sprain and having 3-5 recurrent sprains (p < .001) (Fig. 4).

**Discussion**

The present study retrospectively analyzed patients with acute LAS treated between 2015 and 2018 in the BG Klinikum Duisburg, Germany. Using PROMS (CAIT & FADI) we collected relevant epidemiological information on the distribution of the CAI rate. We identified a higher risk for CAI in females and persons in the age group of 41 to 55 years and we could show that a later therapy onset after acute LAS is associated with increased functional impairments of the ankle. Therefore, early functional treatment following acute LAS seems to be favorable.

The overall CAI rate was about 17% and thus slightly lower than the CAI rates reported in literature ranging between 20 and 40% (6–8). This could be related to methodological differences in study design such as inclusion criteria and inconsistent terminology according to the definition of CAI. In this study CAI was classified according to the CAIT score, which is a recommended criteria from the International Ankle Consortium (14). Our classification is also supported by the FADI since there was a significant difference in the FADI score between the CAI (78.99%) and COPER groups (97.05%).
According to the sex of our patients we found a higher CAI rate in females (21.2%) than in males (10.3%). The females also had higher CAI rates in each of the three age groups. Literature shows that there is a general higher incidence of ankle sprains in females compared with males (13.6 vs 6.94 per 1,000 exposures) (4). This is supported by a higher CAI rate for females in sport (female athletes 32% vs male athletes 17%) (18). Yet there is no explanation for this prevalence, but there are several assumptions such as increased ankle laxity or decreased postural control in females which may contribute to these injuries (19). Additionally, we speculate that the reduced financial and sportsmedical support in female professional sport compared to their male counterparts might also be a contributing factor. Derived from this, females should focus more on specific prevention programs to reduce the occurrence of LAS.

Doherty et al. (2014) state that the incidence of LAS appeared to decrease with age (4). Our data supports this trend but additionally shows that there is a higher CAI rate in older age groups. Currently there is no literature investigating the age distribution of CAI. On the one hand, the higher CAI rate in older age groups could be related to greater levels of sarcopenia with decreased muscle mass and connective tissue as well as increased impairments in postural or sensorimotor control leading to increased ankle instability (20). On the other hand, we suppose that there is a higher CAI rate with increasing age because older individuals might have a longer history of multiple ankle sprains in their life, which is a major risk factor for developing a CAI (5). This is supported by our data in which patients experiencing 1–3 and 3–5 recurrent sprains have significantly worse CAIT outcomes than patients having no recurrent sprains. Furthermore, the mean CAIT of the groups with 1–3 and 3–5 recurrent sprains is below the cut-off score of the CAIT (CAIT < 24), respectively. This implicates that LAS as an injury should be taken seriously and that the focus should be on regaining function as early as possible to prevent recurrent LAS.

Most subjects experienced their LAS during sport (54.5%). This is in line with literature since ankle sprains have a high incidence among physically active persons (5). Herzog et al. (2019) state that the highest rates in LAS were typically reported in sports that are characterized by running, cutting and jumping (5). In contrast, 33.8% reported everyday life as the cause of injury. The prevalence of LAS is therefore not only limited to a sporting population, instead it is present in a huge variety of patients. Thus, the rehabilitation of LAS should be individualized and adapted to the need of the patient.

Our data show that most treatments started more than four weeks after the initial LAS. Interestingly, there was a significant difference in the CAIT score between patients receiving their therapy immediately and patients receiving therapy after more than four weeks. The latter had a worse outcome because of the later therapy onset (Fig. 4). This is supported by studies showing better outcomes for groups with functional support and exercise therapy in contrast to immobilization (21). Additionally, there was a higher percentage of COPER receiving immediate therapy after acute LAS and accordingly a higher percentage of CAI receiving therapy after more than four weeks or no therapy at all following acute LAS (Fig. 4). We suggest that the timepoint of therapy onset can be seen as a relevant risk factor for the development of CAI. It seems the later the therapy onset after LAS the worse the functional outcome.

Limitations
First, to increase the number of valid PROMS we performed an additional telephone interview. The personal communication might have influenced the perception and response behavior of patients which could have affected the outcome variables. Second, as this was a retrospective study, there is a susceptibility to errors since the data might be biased due to the patient's inaccurate recollection of events. Furthermore, given diagnoses cannot be proved retrospectively according to their etiology and completeness.

**Conclusion**

According to this study, female and older age groups have a higher risk for developing CAI which implies to focus on specific prevention or therapy programs improving ankle function. Furthermore, we found meaningful indications that show lower CAIT scores in patients starting their therapy at a later timepoint. Therefore, the onset of therapy seems to be an important risk factor for the development of CAI. A further risk factor for CAI, suggested by literature, is the number of recurrent sprains which could also be shown by our data. Therefore, we highly recommend an early onset of exercise therapy after acute LAS in the future to minimize the development of CAI. According to Miklovic et al (2018) the therapy should be guided by four impairment domains, identified in patients with CAI. These domains consist of range of motion, strength, proprioception, and functional tasks. Further research in this area is needed to empirically evaluate the effectiveness of this treatment concept aiming to reduce the CAI rate.

**List Of Abbreviations**

CAI Chronic ankle instability

CAIT Cumberland ankle instability tool

FADI Foot and ankle disability index

LAS Lateral ankle sprain

PROM Patient related outcome measure

**Declarations**

**Ethics approval and consent to participate**

The study was approved by the local ethics committee (Ärztekammer Nordrhein, 2018363) and subjects provided informed consent.

**Consent for publication**

not applicable
Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

CR, AP and TO contributed to the conception and design of the study. JT performed the data acquisition. JT and CR conducted the data analysis and data interpretation as well as the manuscript preparation and writing. TO, AP, and CS contributed to the revision. All authors read and approved the final manuscript.

Christian Raeder and Janina Tennler contributed equally to this work.

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Figures
**Figure 1**

Flowchart of the study design.
Figure 2

Reported causes of incurring a LAS.

Figure 3

Percentage distribution (left) and functional CAIT outcome (right) according to the onset of exercise therapy.*p<.05
Figure 4

Functional CAIT outcome depending on the frequency of recurrent ankle sprains. *p<.001