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Intrinsic Risk Factors of Lateral Ankle Sprain: A Systematic Review and Meta-analysis

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Context: Lateral ankle ligamentous sprain (LAS) is one of the most common injuries in recreational activities and competitive sports. Many studies have attempted to determine whether there are certain intrinsic factors that can predict LAS. However, no consensus has been reached on the predictive intrinsic factors.

Objective: To identify the intrinsic risk factors of LAS by meta-analysis from data in randomized control trials and prospective cohort studies.

Data Sources: A systematic computerized literature search of MEDLINE, CINAHL, ScienceDirect, SPORTDiscus, and Cochrane Register of Clinical Trials was performed.

Study Selection: A computerized literature search from inception to January 2015 resulted in 1133 studies of the LAS intrinsic risk factors written in English.

Study Design: Systematic review.

Level of Evidence: Level 4.

Data Extraction: The modified quality index was used to assess the quality of the design of the papers and the standardized mean difference was used as an index to pool included study outcomes.

Results: Eight articles were included in this systematic review. Meta-analysis results showed that body mass index, slow eccentric inversion strength, fast concentric plantar flexion strength, passive inversion joint position sense, and peroneus brevis reaction time correlated with LAS.

Conclusion: Body mass index, slow eccentric inversion strength, fast concentric plantar flexion strength, passive inversion joint position sense, and the reaction time of the peroneus brevis were associated with significantly increased risk of LAS.

Keywords: lateral ankle sprain; risk factor; meta-analysis

Lateral ankle ligamentous sprain (LAS) is one of the most common injuries in competitive sports and recreational activities.[7] According to published statistics, 10% to 30% of all athletic injuries are ankle injuries, and in many sports, ankle sprains account for 70% or more of all reported ankle injuries.[7] Ankle sprains are often only partially treated. The rate of recurrent ankle sprain is more than 40%, and repeated ankle sprain in turn can lead to chronic ankle instability (CAI) and ankle osteoarthritis.[17,20,28]

The predictive intrinsic factors of LAS include anatomic characteristics,[4,18] functional deficits in isokinetic strength,[3,16] flexibility,[2,12] joint position sense,[23,25] muscle reaction time,[3] postural stability,[26] gait mechanics,[24] limb dominance,[3,8] previous ankle sprains,[2,16] and body mass index (BMI).[18,21] However, no consensus has been reached on the predictive intrinsic factors for LAS. Although the results of meta-analyses of risk factors leading to ankle injuries have been reported,[27] there are no published systematic reviews that focused solely on LAS.

The objective of this systematic review was to identify the intrinsic risk factors of LAS by using a meta-analysis from data in randomized control trials and prospective cohort studies.

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METHODS

Literature Search

A computerized literature search through January 2015 of the MEDLINE, CINAHL, ScienceDirect, SPORTDiscus, and Cochrane Register of Clinical Trials databases was completed. The search term used was "Ankle AND Sprain AND (Lateral or Inversion) AND Prospective AND (Risk OR Prediction OR Incidence OR Prevention)." The references of the mined studies were screened to identify additional articles.

Inclusion and Exclusion Criteria

Inclusion criteria consisted of randomized control trials or prospective cohort studies, LAS included in the outcome, intrinsic factors as risk factors, written in English, clear presentation of the number of subjects in the injury and the noninjury groups, and data with mean and SD or 95% CIs presented for both groups.

Quality Assessment

The modified quality index (QI) was used to assess the quality of the design of the papers.[5,14,19] The modified QI contains 15 questions.

Data Analysis

Standardized mean differences (SMD) were used as an index to pool study outcomes. Review Manager 5.3 (The Nordic Cochrane Center, The Cochrane Collaboration, 2014) was used to construct forest plots of multiple study outcomes for the same intrinsic factor and calculate 95% CIs. By using the I^2, which determines the heterogeneity of the pooled data, the fixed model was applied when heterogeneity was present and the random effects model was used when heterogeneity was determined to be absent.[11] In addition, funnel plots were created to assess the influence of publication bias in results where $P < 0.05$.

RESULTS

Study Selection and Quality

The search process is outlined in Figure 1. After the systematic review, 8 articles were included in the meta-analysis (Table 1 in the Appendix, available at http://sph.sagepub.com/content/by/supplemental-data).[2-4,8,9,15,25,26] The mean QI score of the included studies was 13.75 (range, 11-15).

Body Mass Index

There was a significant correlation between high BMI and LAS[9]; other studies did not show a significant correlation.[4,15,25,26] The results of the meta-analysis with the fixed effects model showed significantly greater BMI in the injury group than in the noninjury group (Figure 2 in the Appendix, available at http://sph.sagepub.com/content/by/supplemental-data). A symmetric shape was observed in the funnel plot (Figure 3 in the Appendix, available at http://sph.sagepub.com/content/by/supplemental-data).

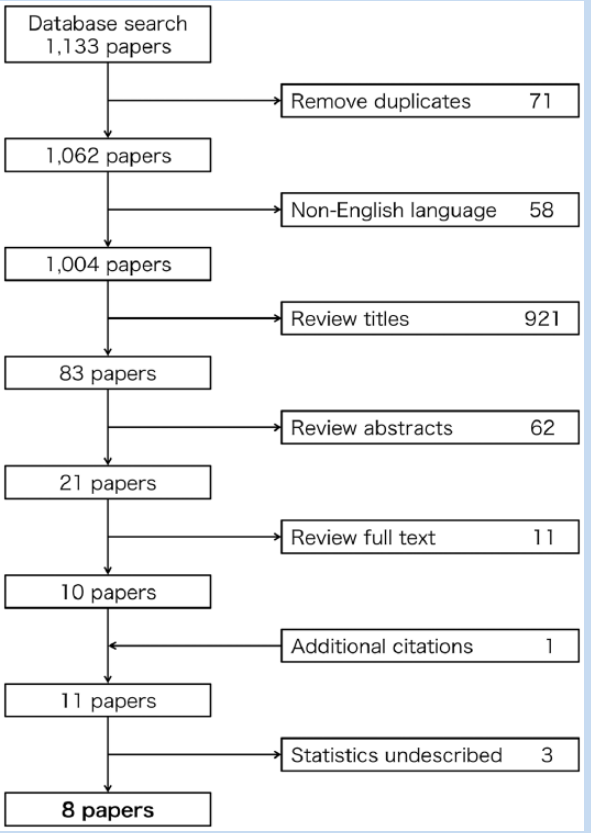

Figure 1. Literature search process.

Range of Motion

There was a significant correlation between deficient ankle dorsiflexion range of motion (ROM) and LAS[25]; other studies did not show a significant correlation.[2-4,9,15,26] The meta-analysis showed no significant difference in the ankle joint ROM (dorsiflexion/plantar flexion/inversion/eversion) between the injury and noninjury groups (Figures 4-7 in the Appendix, available at http://sph.sagepub.com/content/by/supplemental-data).

Muscle Strength

The meta-analysis showed that decreased slow eccentric ankle inversion strength and increased fast concentric plantar flexion strength significantly correlated with LAS (Figures 8 and 9 in the Appendix, available at http://sph.sagepub.com/content/by/supplemental-data). Other patterns of muscle strength did not show a significant correlation (Figures 10 and 11 in the Appendix, available at http://sph.sagepub.com/content/by/supplemental-data).

Postural Stability

There was a significant correlation between poor static postural control and LAS[25]; no other study showed a significant correlation. Meta-analysis results using the random effects

model showed that there was no significant difference in the static postural stability between the injury and noninjury groups (Figure 12 in the Appendix, available at http://sph.sagepub.com/content/by/supplemental-data).

Proprioception

There was a statistically significant difference in the passive inversion joint position sense between the injury and noninjury groups (Figure 13 in the Appendix, available at http://sph.sagepub.com/content/by/supplemental-data). However, there was no significant difference in active inversion joint position sense (Figure 14 in the Appendix, available at http://sph.sagepub.com/content/by/supplemental-data). The decreased kinesthesia was not significantly different between the injury and noninjury groups (Figure 15 in the Appendix, available at http://sph.sagepub.com/content/by/supplemental-data).

Muscle Reaction Time

The fixed-effects model revealed a significantly earlier reaction time of the peroneus brevis (Figure 16 in the Appendix, available at http://sph.sagepub.com/content/by/supplemental-data). However, no significant differences in reaction time of the peroneus longus and the tibialis anterior were found between the injury and noninjury groups with the random effects model (Figures 17 and 18 in the Appendix, available at http://sph.sagepub.com/content/by/supplemental-data). With regard to the reaction time of the peroneus brevis, a symmetric shape was observed in the funnel plot (Figure 19 in the Appendix, available at http://sph.sagepub.com/content/by/supplemental-data).

DISCUSSION

The meta-analysis showed that BMI, slow eccentric inversion strength, fast concentric plantar flexion strength, passive inversion joint position sense, and the reaction time of the peroneus brevis have significant correlations with LAS.

The results of this study partially supported the results of the meta-analysis performed by Witchalls et al,[27] but the criteria for meta-analysis used in this study were different from those in the previous review.

Lateral ankle ligamentous sprain commonly occurs during plantar flexion and inversion with excessive ankle supination.[22] Therefore, LAS is associated with decreased ankle eversion strength or delayed ankle evertor muscle reaction time.[10] However, this review did not support these hypotheses. Decreased ankle eversion strength[1] or delayed ankle evertor muscle reaction time[13] were observed in chronic ankle instability. Therefore, these dysfunctions are possibly acquired after LAS and may not be risk factors for LAS itself.

This study has a number of limitations. Since the majority of study subjects included in this meta-analysis were young adults, these findings may not be applicable to children or elderly individuals. This study did not consider the injury mechanism (eg, initial or recurrent, contact or noncontact); this could impact conclusions and its clinical application. Although this review investigated publication bias by funnel plot, the possibility of β-error may be greater because the number of papers included in this meta-analysis was less than 10.[6]

CONCLUSION

Body mass index, slow eccentric inversion strength, fast concentric plantar flexion strength, passive inversion joint position sense, and reaction time of the peroneus brevis showed significant correlations with LAS.

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