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Brace beats Balance Board

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Round 1

General Introduction

Kasper W Janssen

To train, or to brace, or both, that's the question

Intro

Fifty percent of all ankle sprains occur during sports¹. High risk sports are basketball, handball, volleyball and soccer^{2, 3}. Incidence rates of ankle sprains in sports range from 0.5 to 5 per 1000 exposures (Table 1)³⁻⁵. Traditionally, an ankle sprain is categorized in grades, ranging from 1 to 3, i.e. from light to severe damage to the ankle ligaments. However, it should be noted that the severity of the sprain does not necessarily predict long term outcomes⁶. Around 50% of the sprains receive some form of (para)medical treatment⁷. While 60 to 90% of recreational athletes that sustain an ankle sprain resume sports at their previous level after 12 weeks⁸, the relative risk of a re-injury is doubled in the following year⁹. Even more so, up to 40% of these recurrent sprains result in chronic ankle instability⁸. Despite the high incidence¹⁰ and severity of lifestyle limiting¹¹ symptoms of ankle sprains, in general these injuries are often regarded as simple injuries that do not need specific treatment other than RICE (rest, ice, compression and elevation), and that will resolve naturally^{12, 13}. Though, a recent discussion in the literature has argued that evidence for 'rest' in RICE is lacking and instead we should recall the POLICE¹⁴ acronym (protection, optimal loading, ice, compression, and elevation) in case of an acute ankle sprain.

Prevention of these injuries is only mentioned in the byline of most clinical treatment protocols¹³. Only recently, a Dutch multidisciplinary clinical practice guideline on ankle sprains included prevention of further health impairment as an important goal, besides treatment in the acute phase¹⁵.

Table 1. Ankle sprain incidence rates and prevalences in sports. Adapted from Doherty et al.³

| Sport | Cumulative incidence per 1,000 exposures | Incidence per 1,000 athlete exposures | Incidence per 1,000h | Prevalence (%) |
|---------------------|--|---------------------------------------|----------------------|--------------------|
| Field sports | 1 (0.95-1.05) | 1.2 (0.86-1.50) | 3.9 (3.45-4.24) | 11.3 (11.15-11.44) |
| Indoor/court sports | 7 (6.82-7.18) | 1.4 (1.05-1.70) | 4.9 (3.30-6.50) | 12.2 (12.01-12.33) |
| Ice/water sports | 3.7 (3.30-4.17) | 0.5 (0.22-0.71) | 0.5 (0.25-0.70) | 4.4 (3.92-4.79) |
| Outdoor sports | 0.9 (0.73-1.02) | - | - | 11.7 (11.33-11.97) |

Prevention of ankle sprains

In an attempt to prevent ankle sprains, one of the first randomized controlled trials was performed by Garrick et al¹⁶ in 1973, concerning the use of high-top shoes and ankle taping of basketball players. Overall, taping showed a significant reduction in the occurrence of ankle sprains (OR 0.44, 95% CI 0.24 to 0.79). Participants with a history of a previous ankle sprains were about twice as likely to be injured as the previously uninjured participants (27.7 vs 13.9 sprains/1000 player games). Although this trial showed that ankle taping was an effective intervention for ankle sprain prevention, to date there are no randomized controlled trials that have replicated these results. While taping is still a popular preventive measure, in the long run it is an expensive intervention, which requires skills and technique to apply effectively²⁸. Therefore two alternative interventions were developed: neuromuscular (NM) training and bracing.

While all preventive measures have their own working mechanism, their final goal is prevention of ankle sprains. From a societal and costs perspective it is relevant to know which of these measures is most effective in preventing ankle sprains. Therefore, the first chapter in this thesis is a condensed version of our Cochrane review, that summarizes the available interventions preventing ankle ligament sprains.

To train...

NM training was developed to restore proprioceptive and neuromuscular functions. These functions are severely altered after an ankle sprain due to damaged ankle ligament receptors¹⁷. Resulting functional deficits are limited postural control, decreased maximal strength of the evertor muscles and prolonged muscle reaction time¹⁸. Even after successful return to play, ongoing deficits in neuromuscular control may contribute to a higher risk of a recurrent injury¹⁹. For example, athletes with a history of ankle sprain have greater fatigue-induced alterations of dynamic postural control¹⁹. Therefore, the goal of NM training as secondary ankle sprain prevention is to improve and optimize sensorimotor control, and to restore and enhance proprioceptive and neuromuscular abilities²⁰.

The exercise programs vary from balance exercises on stable or unstable platforms to multi-faceted exercise programs, with a combination of balance, weight, plyometric, agility, and sport-specific exercises^{21, 22}. While group-based NM training is preferred for team sports, individual NM training has also shown to be effective. For instance, it has been shown that risk of ankle sprain recurrence could be reduced with 35% by an eight weeks home-based NM training program, which was offered after 'usual care' for the index ankle sprain²³. It was further concluded that proprioceptive training was specifically beneficial as secondary prevention in athletes whose index sprain was not medically treated²³.

...or to brace,.....

The mechanism of prevention of ankle sprains by external ankle supports, or braces, has been an ongoing unresolved scientific discussion. The classic theory of bracing is mechanical stabilisation of the ankle joint and ligaments by limitation of inversion and eversion of the talus relative to the distal fibula²⁴. Braces are also thought to improve the strength of the muscular response to perturbation, potentially providing a stronger muscular contraction²⁵. Along the same theory braces could slow down the inversion motion, hereby allowing the neuromuscular system to respond at or before the point of ligament damage²⁵. Finally, it is an ongoing debate in the literature if ankle supports could transfer loads to other joints putting them at risk for injury²⁶.

Early evidence for preventive bracing versus taping in limiting ankle range of inversion motion was provided by the use of rigid or semi-rigid braces²⁷. Only two-and-a-half decades later McGuine published the first real evidence of the effectiveness of lace-up ankle braces in high school basketball players with and without a history of an ankle injury³⁵. These results were replicated for high school football players by the same author. Though, an overview of the recent literature, preferably an updated Cochrane review, on the effectiveness of ankle braces for ankle sprain prevention in adult athletes, but also in the general population, is missing.

...or both, that's the question!

An early attempt to describe the cost effectiveness of taping versus bracing revealed taping to be approximately 3 times more expensive than bracing for secondary prevention of ankle sprains in athletes²⁸. A more recent study in high school football found an even larger cost benefit ratio in favour of bracing over taping²⁹. For NM training it has been shown that an 8 weeks program after usual care is cost-effective for the prevention of ankle sprain recurrences in comparison with usual care alone²³. In contrast, NM training and bracing were never compared head to head for secondary ankle sprain prevention. Figure 1 presents a model developed by Verhagen & Bay to explain the effects of both measures on ankle sprain recurrence risk³⁶. After the index ankle sprain the model assumes an increased risk of a recurrence for approximately one to two years. Tape or brace application during sports is thought to directly decrease this risk of a recurrence to 'baseline', while performing NM training requires 8 to 10 weeks to bring this risk back to 'baseline'. This model was the basis for developing a three arm randomized controlled trial to compare an 8 weeks home-based NM training program to one year of bracing during sports and the combined intervention during 8 weeks.

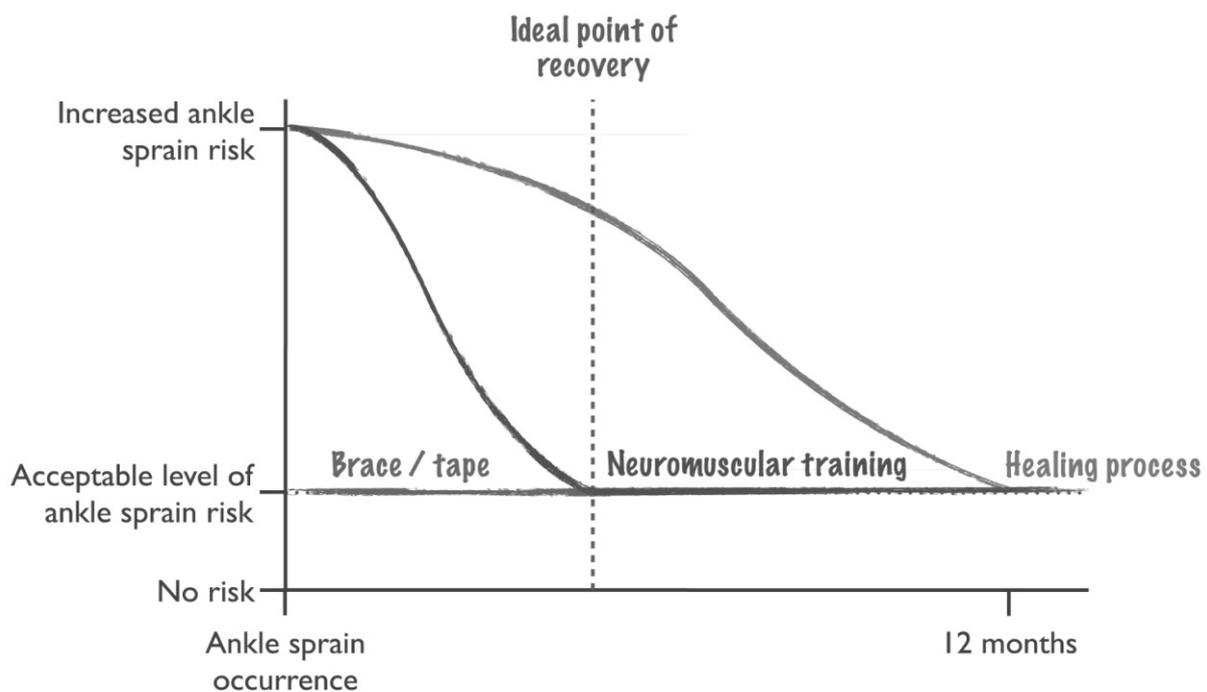


Figure 1 Theoretical concept for optimal ankle sprain prevention. Adapted from Verhagen & Bay, 2010.

If these interventions work, why don't athletes use them?

When it is known which interventions work, an important issue to address is compliance with these interventions in daily application in sports. In sports injury prevention research, compliance is a term used to indicate the athlete's correct execution of the prescribed intervention. In a previous trial on home-based NMT for ankle sprains by our group a secondary analysis on athletes who fully complied with the training program showed that the established intervention effect was over threefold

higher compared to an earlier intention-to-treat based analysis approach³⁰. In other words, the more the athletes actually performed the exercises, the more recurrent injuries were prevented. In current research ample information is available on factors that influence compliance with, or in a broader perspective adherence to, NM training^{31, 32}. Accordingly, research on factors that can predict compliance with NM training, but also bracing or the combined intervention is needed.

Can athletes decide which brace fits (and works) best?

If bracing is effective and compliance with bracing is sub-optimal, how can we further increase the uptake of the intervention in different sports by different athletes? Early brace studies already suggested that provided mechanical support should be balanced with perceived comfort of brace use³³. Later studies have confirmed that clinicians take into account factors as subjective comfort when prescribing an ankle brace to individual athletes³⁴. The resulting hypothesis is that subjective factors of brace use are quantifiable and can influence the acceptability of brace use by athletes. In other words, can we let the athlete decide which brace fits (and works) best?

Thesis Outline

The main objective of this thesis is preventing ankle sprains in athletes by providing evidence for effective interventions and advice on implementation of such interventions. **Chapter 2** in this thesis is a condensed version of a Cochrane review, that summarises the evidence for interventions preventing ankle ligament sprains. Subsequently, an RCT was designed to evaluate the (cost-)effectiveness of combined bracing and NM training, or bracing alone, versus the use of NM training on recurrences of ankle sprain, that we describe in **Chapter 3**. **Chapter 4** presents the effects of the interventions on injury incidence from this three-arm randomized controlled trial. **Chapter 5** describes the comparative cost-effectiveness analyses of the combined interventions versus brace, versus balance board. **Chapter 6** presents potential predictors for athlete compliance with these interventions, based on a secondary analysis of the compliance data from the study in Chapter 5. **Chapter 7** contains a user survey of three ankle brace-types in soccer, volleyball and running to assist athletes, coaches and practitioners in selecting an optimal ankle brace for ankle sprain prevention. **Chapter 8** is a general discussion of the methods and results presented in Chapters 2 to 7, after which recommendations for future research are made and implications of the findings for the prevention of ankle sprains in practice are discussed.

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