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Wrist overuse in young athletes

Exploring diagnostic strategies

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CHAPTER 11

Summary

Summary

“I will need my wrist for longer than for just one more year. It needs to last me for the rest of my life.”

- Judoka, 17 years old

Wrist overuse in young athletes: exploring diagnostic strategies

The three parts of this thesis addressed three research questions, in order to provide diagnostic strategies for early identification of overuse injuries of the wrist in young athletes. The first part focused on the epidemiology of effects of wrist-loading sports performance during youth, by aiming to answer the question what the extent is of the risks and benefits of performing wrist-loading sports at a young age. In the second part we aimed to answer the question what relevant signals and limitations are relating to overuse wrist injuries in young athletes, in order to incorporate them in a self-report tool. The third part focused on answering the question what diagnostic imaging techniques can improve the early diagnosis of overuse wrist injuries and their potential consequences in young athletes.

Part I – The population perspective

In **Chapter 2**, we systematically reviewed the literature to reveal the prevalence and incidence of overuse wrist injuries in young athletes, and to identify associated risk factors. In the resulting 11 studies prevalence and incidence of overuse wrist injuries were high, up to 28%, and even higher for wrist pain, up to 73%, in multiple studies of gymnasts. In addition, we identified three key risk factors for wrist pain in gymnasts: age between 10 and 14 years, early training commencement, and high training intensity. We found that the literature focused mainly on gymnasts under the age of 18 years, and noticed there is a lack of information on the occurrence and risk factors of overuse wrist injuries in young athletes performing wrist-loading sports other than gymnastics. We also concluded that wrist pain will be a good definition to use in detecting overuse injuries of the wrist in young athletes performing wrist-loading sports, because using a ‘time loss’ or ‘medical attention’ definition may result in under-reporting.

More knowledge of the benefits and risks of performing popular wrist-loading sports at a young age allows sports medicine professionals to present athletes and their parents with a complete picture of both positive and negative, immediate and long-term health effects. In **Chapter 3**, we therefore systematically reviewed 23 studies evaluating health effects of the upper extremities in athletes practicing wrist-loading sports (gymnastics, tennis, volleyball, field hockey, rowing and judo) before the age of 18. While research often focuses on acute negative consequences like sports injuries, we found that wrist-loading sports performance during youth can actually promote bone strength in the wrist and dominant hand grip strength, but that the evidence on the sustainability of these effects is limited. With respect to negative consequences like ulnar variance, the results were inconclusive, even though it has been suggested that positive ulnar variance is more pronounced in

gymnasts as compared to non-gymnasts, leading to long-term wrist pain. We did not find any data on the prevalence of wrist joint degeneration in former young athletes. This issue requires attention in future studies, because osteoarthritis of hip and knee joints is frequently seen in athletes who formerly performed running-related activities, and comparable repetitive mechanical loading of the wrist and overuse injuries as a result of microtrauma often occur in wrist-loading sports.

Part II – The sports perspective

In **Chapter 4**, a focus group of seven experienced sports physicians discussed signals and limitations related to overuse wrist injuries in young athletes. This resulted in seventeen important signals, like pain, crepitations, swelling and limited range of motion, and three important limitations, like influence on sports performance, which were all considered indicative of overuse wrist injury. Sports physicians suggested to focus not primarily on the term “pain”, as it may not be the presenting symptom, but also on additional symptoms such as crepitations, swelling and limited range of motion, and on limitations in sport that young athletes may not always recognize or interpret as indicators of overuse injury. They further emphasized that young athletes may not report sport-related limitations until serious injury is present, and that missing elements of training or competition, using pain medication, or exhibiting nonverbal signs such as the use of tape or a brace can be signs of overuse injury. Finally, the sports physicians stated that overuse wrist injury can present with acute onset of symptoms. In order to accurately identify overuse wrist injury in young athletes presenting with sudden wrist problems, a physician therefore needs to inquire about previous wrist injury, symptoms preceding the acute onset and whether the athlete’s recent training load is in keeping with the symptoms. The items in Chapter 4 provided the basis for the SOS-WRIST questionnaire to identify overuse wrist injury in young athletes.

In **Chapter 5**, we reported the outcomes of a focus group study of 21 athletes aged 13-25 years in wrist-loading sports with a (previous) overuse wrist injury, to compare the results of Chapter 4 with the opinions of young athletes. They discussed 101 important signals and limitations of their injury, as well as the items collected from sports physicians. In contrast to the opinions of sports physicians, the athletes considered limitations in activities of daily life more important indicators to identify and evaluate overuse wrist injuries and many regarded sport-related pain and limitations as a natural part of their sport. Other indicators of overuse wrist injury, according to the athletes, were long pain duration, acute onset of pain, and accompanying symptoms like swelling, cracking and discoloration. We concluded that discrepancies exist between the opinions of young athletes and sports

physicians on sport-related pain reporting and competing regardless of pain or limitations. Although clinicians may be inclined to focus on sport-related aspects, they should be aware that young athletes find it difficult to distinguish 'just a pain' from an overuse injury, and therefore they should also inquire specifically about limitations and pain during daily life activities, like brushing teeth or writing.

In order to enable young athletes themselves to identify overuse wrist injuries, we developed the SOS-WRIST questionnaire, which is described in **Chapter 6**. Combining the input from sports physicians and athletes derived from Chapters 4 and 5 with items derived from the literature, we collected 110 important items. A six-person expert panel and 40 Delphi study participants further reduced these items to 18 multiple-choice questions regarding wrist pain during sports and daily life activities, and other symptoms. Based on the comments of 13 athletes during individual interviews, these questions were further adapted and the SOS-WRIST was subsequently translated into English. The expert-based input of these 13 athletes and 40 sports medicine professionals led us to conclude that the SOS-WRIST has adequate content validity. Even though not all measurement properties (like reliability and responsiveness) have been evaluated as yet, the 'red flags' it raises can already aid in the timely identification of overuse wrist injuries. In addition, the SOS-WRIST can help create more injury-awareness among athletes, coaches, trainers, and parents, and encourage young athletes with overuse wrist injuries to seek help early.

Part III – The imaging perspective

Because one of the challenges in early diagnosis of growth plate stress injury of the wrist is the systematic evaluation of stress-induced and maturation-related changes, we developed, in **Chapter 7**, a short protocol for MRI assessment of the distal radial and ulnar growth plate area in gymnasts and non-gymnasts and evaluated its inter- and intrarater reliability. We used prospectively collected MRI scans with cartilage- and water-sensitive sequences of 66 children: gymnasts with wrist pain, asymptomatic gymnasts, and non-gymnastic controls. After three experienced musculoskeletal radiologists had established a checklist of 27 potential abnormalities, based on literature and clinical experience, five other musculoskeletal radiologists and residents evaluated 30 MRI scans (10 from each group) using this checklist. This resulted in the final Amsterdam MRI assessment of the Physis (AMPHYS) protocol, which contains 12 items with expert-based content validity and intraclass correlation coefficient or Fleiss' kappa values of 0.41-0.91, representing fair to excellent reliability. Numerous signs that were previously considered indicative of growth plate stress injury were also found to be present in young

non-gymnasts, leading us to conclude that future prospective systematic assessment of the growth plate on MRI using the AMPHYS protocol can provide clinical grades of maturation- and stress-related physeal changes.

In **Chapter 8**, we aimed to further improve early diagnosis of physeal stress injury by developing and validating a semi-quantitative Dixon MRI-based method to determine metaphyseal water content. On prospectively collected coronal T1- and T2-weighted Dixon MRI scans from 24 gymnasts with wrist pain, 18 asymptomatic gymnasts, and 24 non-gymnastic controls, we measured the metaphyseal water signal fraction in 13 areas in the distal radius and ulna. The water signal fraction in six of these areas was significantly higher in symptomatic gymnasts than in asymptomatic gymnasts and non-gymnasts ($p < 0.05$). After calculating a 'metaphyseal water score', using a within-person reference area of unaffected metaphyseal bone, we found that the ratio of an area 5-10 mm proximal to the physis versus an area 20-25 mm proximal to the physis was significantly higher in symptomatic gymnasts than in asymptomatic gymnasts ($p < 0.05$) on both sequences. The method showed good to excellent inter- and intrarater reliability with intraclass correlation coefficients of 0.79-1.0, indicating that this metaphyseal water score can potentially be used in the early diagnosis of gymnastic physeal stress injury.

Although distal radial growth plate stress injury is thought to cause positive ulnar variance, negative and neutral ulnar variance have also been described in young gymnasts. There are multiple methods available for ulnar variance measurement. To facilitate future studies on the relationship between physeal stress injury and ulnar variance, we determined the reliability and the intermethod consistency between the perpendicular method and the Hafner method in **Chapter 9**. Two musculoskeletal radiology experts measured ulnar variance on hand radiographs of 350 healthy children, using both methods, which showed an intraclass correlation coefficient of 0.60, defined as moderate intermethod consistency. Inter- and intrarater reliability of the Hafner method was good to excellent with intraclass correlation coefficients of 0.81-0.94. For the perpendicular method, reliability was good, with intraclass correlation coefficients of 0.75-0.88, after we composed more detailed measurement instructions than those available in the literature. This illustrated that the knowledge and use of uniform measurement methods is essential when comparing clinical outcome measures. We recommended that clinicians choose the Hafner method for ulnar variance measurement in children with skeletal ages younger than 14 years, and the adapted perpendicular method for patients with skeletal ages of 14 years and older.

The research reported in these eight chapters has elaborated numerous strategies to improve the early diagnosis of overuse injuries of the wrist in young athletes, providing a self-report tool and qualitative as well as quantitative imaging techniques. In addition, the three perspectives presented in this thesis have illustrated the diagnostic challenges for young athletes, in particular their difficulties in reporting injuries and the normalization of pain in youth sports. Among clinicians and researchers, there is a clear need for uniform definitions and validated diagnostic methods for early identification of overuse wrist injuries. Furthermore, the definition of 'normal' – with regard to symptoms as well as diagnostic imaging – needs to be refined to be better applicable to young athletes. A multidisciplinary approach is essential to overcome these challenges, combine these diagnostic strategies and involve athletes, coaches, trainers, parents, and physicians alike.