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Perfecting your Pitch

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Summary

Introduction

Pitchers play an important role in baseball games and have a considerable share in their outcomes. A pitcher's success is in large part determined by his ability to generate high ball velocities. Such an explosive throw places high demands on the pitcher's body, which together with the high work load results in high injury rates and in professional baseball, in a corresponding loss of invested player salaries. To gain a better understanding of the possibilities to improve the performance of pitchers and to decrease the risk of injury, quite a number of mechanical studies have been performed. These studies were focused predominantly on kinematic and kinetic variables and their relation with throwing velocity and the associated injury mechanisms. In this context the mechanical load on individual joints was examined, but the interaction between joints remained thus far underexposed. In contrast, the focus of the biomechanical research in the present thesis is on the coordination between limb segments and the potential role of intersegmental timing on the generation of high throwing velocities in elite pitchers. Detailed research on the kinematic chain in pitching can identify essential movement characteristics that contribute to a high throwing velocity and a low risk of injury. A crucial question in this regard pertains to the types of instruction and feedback that should be provided for this purpose. Numerous studies have shown that instructions that direct the learner's attention towards the effect of the movement in the environment (an external focus of attention) rather than towards the movement itself (an internal focus of attention) improve both motor performance and motor learning. This seems very relevant for pitching, in the context of which clear environmental goals can be identified on which the pitcher's attention may be focused. In the present thesis it is therefore investigated to what extent baseball coaches introduce an external focus of attention while instructing young talented pitchers, and whether the effectiveness of these instructions is indeed greater than instructions evoking an internal focus of attention.

Aim

The overarching aim of this thesis was to gain insight into the conditions that lead to fast and safe pitching and how young elite baseball trainers can be trained to this effect.

Results

In this thesis a number of variables were identified that are associated with fast and safe throwing. In **chapter 2**, the association between the timing of sequential rotation of body segments and throwing velocity was examined by measuring the rotation velocity using the marker set-up recommended by the International Society of Biomechanics (ISB). The study was conducted with a homogenous group of young elite pitchers; within this group of found the inter-

segmental timing between pelvis and thorax was found to be a predictor of throwing velocity. In **chapter 3** empirical evidence was found for an association between throwing velocity and knee extension of the lead leg after front foot contact as well as peak thorax rotation velocity. The findings in this chapter were in agreement with those of previous studies on the kinematics of the baseball pitch. **Chapter 4**, the last chapter of the first part of the thesis, provides insight into the development of the functionality of the shoulder. The level of upward scapular rotation was examined in young baseball players at different degrees of upper arm abduction. during upper arm abduction was studied in elite youth pitchers. It was found that in the static abduction positions than the scapula of the other arm. Insight into the asymmetry and the difference in functionality between the throwing arm and non-throwing arm might have implications for the prevention of injuries during training.

In the quest for optimal instruction and feedback methods three studies were performed. In the first of these (**chapter 5**), it was investigated which types of instruction are routinely provided by pitching coaches during training. Pitching coaches gave twice as many instructions evoking an internal focus of attention than instructions evoking an external focus of attention. In view of the scientific literature about the effects of both types of instruction and the fact that in the training environment of baseball multiple external goals are present, this seems a relevant finding. A possible explanation for his gap between scientific knowledge and sports practice came to the fore in the literature review presented in **chapter 6**. This review revealed that most scientific studies on sports covered a relatively short time span of training in a laboratory or another strongly controlled environment, and generally involved students or novices as participants, as a result of which generalization to the daily training practice of experts is hardly possible. For this reason an ecologically more valid randomized controlled trial was conducted to chart the effects of instructions evoking an external and instructions evoking an internal focus of attention. This study was performed with pitchers from the national youth teams of Belgium, Germany, Italy and the Netherlands during their regular training and with their own coaches. After a five-week long training period no consistent differences were found in the tested performances as a function of both types of instruction. This finding contradicts with what was found in most previous studies. A possible explanation for this discrepancy is that the pitchers had long received internal-focus-of-attention instructions from their coaches, and were therefore more familiar with this type of instructions. Another possible explanation is that the skill level of the pitchers was already very high, as a result of which a ceiling effect may have occurred. In the last chapter (**chapter 7**), a sensor sytem was developed that provides real-time feedback about the rotation velocities of pelvis and thorax and the timing between the moment of peak rotation of both segments. The feedback system was used in a two-day intervention study, which

revealed that internal-focus-of-attention instructions in combination with real-time feedback resulted in the greatest improvement (viz. faster rotations) in the movement characteristics of the pitchers. Although this improvement was only of short duration, feedback about the pitching movement seems to be useful in bringing about, and perhaps also acquiring, of a fast and safe throwing technique.

General conclusions and further recommendations

The overarching aim of this thesis was to gain insight into the conditions that lead to fast and safe pitching and how young elite baseball trainers can be trained to this effect. We conclude that the training of pitchers should be focused on improvement of the relative timing between the peak rotation velocity of the pelvis and the thorax because this relative timing is closely associated with the throwing velocity. Also the rotation velocity of the thorax and the extension of the knee after front foot contact were associated with throwing velocity. Therefore, pitching training may be focused on these aspects as well.

Although the baseball training environment provides ample opportunities for the coach to direct the attention of pitchers externally, these are hardly used by pitching coaches. However, in an ecologically valid randomized clinical trial no statistically significant difference was found in effectivity between instructions evoking an external focus of attention and instructions evoking an internal focus of attention. Further research is needed to gain more insight into the type of instructions that are most beneficial for elite pitchers; in this research it should be ensured beforehand that the participants are sufficiently familiar with the instructions provided. It was also concluded that internal-focus-of-attention instructions in combination with real-time technical feedback can provide an effective method to change the movement technique of players within a single session. Future research is needed to determine how long this effect is preserved after training and how retention might be improved.

The findings presented in this thesis underscore the need to further develop innovative real-time feedback for baseball pitching training. Feedback from sensors can provide both players and coaches with information about the execution of the pitching action and increase the effectivity of instructions of coaches about this execution.