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Mini Review

Ankle Dorsiflexion does not Significantly Correlate with Varus Torque at the Elbow in Collegiate Baseball Pitchers

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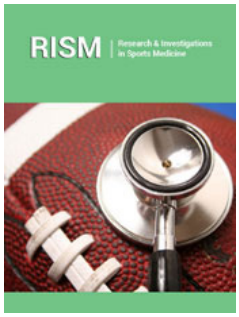

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Abstract

Baseball pitching places unique stress on the glenohumeral joint, with the upper extremity rotating at a rate of over 7,000o/s. Despite efforts to address the high rate of shoulder and elbow injuries in baseball pitchers, injury prevalence continues to rise. Multiple risk factors have been identified, including fatigue, height, and mass. Another previously identified independent risk factor for shoulder and elbow injuries in pitchers is a lack of dorsiflexion in the ankle of the pitcher's back leg. There was no causation established between a lack of ankle dorsiflexion and increased prevalence of elbow and shoulder injuries in baseball pitchers in the previous study. Therefore, the purpose of this study was to assess the relationship between ankle dorsiflexion and plantarflexion, and normalized varus torque at the medial elbow of the throwing arm in collegiate baseball pitchers. Seventeen male (age 21.6 ± 1.90) collegiate baseball players participated in this study. Participants completed goniometric measurement of ankle dorsiflexion and plantarflexion, as well as the Y-balance lower extremity test. Participants also wore an inertial measurement unit on their medial elbow to measure arm speed and varus torque at the medial elbow while throwing. Pearson's correlations were conducted to assess relationships between normalized varus torque at the medial elbow, anterior reach, posterolateral reach, posteromedial reach, active plantarflexion of the front and back leg, active dorsiflexion of the front and back leg, arm speed, height, and mass. An independent samples t-test was run to assess differences in normalized varus torque between participants with less than 10 degrees of active dorsiflexion in their back leg and participants with 10 or more degrees of dorsiflexion in their back leg. Significant positive correlations were found between normalized varus torque, height, and mass. However, no significant correlations were found between normalized varus torque and measures of dynamic and static ankle range of motion. Individuals with 10 or more degrees of active ankle dorsiflexion in their back foot experienced 13.8% more normalized varus torque at the medial elbow when throwing ($t(15) = -2.45$, $p = .027$). These results suggest an increase in varus torque at the medial elbow may not be the causative factor for increase shoulder and elbow injuries in pitchers with lower ankle dorsiflexion. Future research should look further into the effects of dynamic and static ankle range of motion on pitching mechanics and other factors that may predispose pitchers to shoulder and elbow injuries.

Introduction

Roughly 116,00 shoulder injuries are sustained by high school student-athletes each year [1]. Injuries to the shoulder and elbow are of particular concern for sports medicine healthcare professionals providing care for baseball pitchers [1-5]. Rules and protocols have been adjusted in several baseball leagues in an attempt to decrease injury rates. These changes have included maximum pitch counts, and obligatory rest days between pitching. Even with these efforts, injury rates continue to rise [1-5].

Once participating at the elite college and professional levels, injuries to pitchers also involve the risk of lost future earnings and financial compensation. The financial implications of injuries to pitchers can be a source of stress and anxiety, especially when future finances are potentially affected [6]. While monetary concerns of players may be an area of emphasis, surgical intervention and long-term treatment protocols have the potential to negatively

impact the throwing mechanics of pitching [7]. Changes to throwing mechanics have the potential to decrease performance output, and place pitchers at an increased risk of reinjury [7]. This combination of factors may lead to a decrease in quality of life for pitchers who suffer elbow and shoulder injuries [8]. These concerns have made decreasing the risk of injury and subsequent invasive intervention a point of emphasis in research related to baseball pitchers.

A number of variables have been examined when studying risk factors for elbow and shoulder injuries in pitchers. These factors include, number of pitches thrown during a season, height, and mass [9,10]. Recent studies have called into question how accurately these risk factors are measured. Regarding pitch counts, these measures do not account for throws made during practices [11,12]. As such, the use of wearable technology has begun to be incorporated in practice sessions to better measure the workload being placed on baseball pitchers [13]. Another previously identified independent risk factor for shoulder and elbow injuries in pitchers is a lack of dorsiflexion in the ankle of the pitcher's back leg [14]. Although this risk factor was well described in the previous study, there was no causation established between a lack of ankle dorsiflexion and increased prevalence of elbow and shoulder injuries in baseball pitchers. Therefore, the purpose of this study was to assess the relationship between ankle dorsiflexion and plantarflexion, and normalized varus torque at the medial elbow of the throwing arm in collegiate baseball pitchers.

Methods

Participants

Seventeen male (age 21.6 ± 1.90 years; height 175.61 ± 21.41cm; weight 80.33 ± 8.07kg) collegiate baseball players participated in this study. All subjects were members of an NCAA Division II baseball team. All subjects were screened for a history of significant lower extremity injury, which was defined as a lower extremity injury that resulted in any lost time from participation in organized team activities. Subjects were educated on the risks and benefits of the study, and provided informed consent prior to the beginning of data collection. This study received approval from The University of Texas at Tyler Institutional Review Board.

Data collection

In this study, lower extremity y-balance test (YBT) scores were taken in the anterior, posteromedial, and posterolateral directions for both legs to assess dynamic range of motion at the ankle. The Lower Quarter Y-Balance Test is a measure of lower extremity strength, neuromuscular control, and balance [15]. Subjects completed three trials in each direction for both legs. Based on the YBT scoring protocol, the highest score in each direction was used for data analysis [15].

To assess static active range of motion for ankle dorsiflexion and plantarflexion, goniometric measurements were taken. The axis of the goniometer was placed directly inferior to the lateral malleolus. The stationary arm of the goniometer was aligned with the fibular head. The moving arm of the goniometer was aligned parallel to the fifth metatarsal. Measures for dorsiflexion and plantar flexion were taken three times, with the average measurement being used for data analysis.

To assess varus torque at the medial elbow (Nm) and arm speed (degrees/s), a wearable inertial measurement unit (DriveLine PULSE, DriveLine, Kent, WA) was placed two finger widths below the medial humeral epicondyle of the participant's throwing arm [16]. The inertial measurement unit was housed in either a neoprene sleeve or a fabric strap depending on the participant's preference. Participants wore the inertial measurement unit during all throwing taking place during practices while participating in their fall offseason program. Throwing effort was determined based off a proprietary algorithm developed by the manufacturer, and only varus torque and arm speed from high effort throws were incorporated into data analysis.

Statistical analysis

After data collection was completed, data was compiled and analyzed for statistical significance. Varus torque at the elbow was normalized by dividing the average varus torque at the medial elbow while throwing by the participant's mass in kilograms (Nm/kg). Pearson's correlations were conducted to assess relationships between normalized varus torque at the medial elbow, anterior reach, posterolateral reach, posteromedial reach, active plantarflexion of the front and back leg, active dorsiflexion of the front and back leg, arm speed, height, and mass. An independent samples t-test was run to assess differences in normalized torque between participants with less than 10 degrees of active dorsiflexion in their back leg and participants with 10 or more degrees of dorsiflexion in their back leg. All statistical tests were performed using SPSS V28 (IBM, Armonk, NY).

Result

Significant correlations are presented in Table 1. There were no significant correlations between normalized varus torque at the medial elbow and dynamic or static ankle dorsiflexion. Individuals with 10 or more degrees of active ankle dorsiflexion in their back foot experienced 13.8% more normalized varus torque at the medial elbow when throwing ($t(15) = -2.45$, $p = .027$).

Table 1: Significant correlations between factors.

Factors	Correlation	Strength
Normalized Torque and Arm Speed	($r(15) = -.665$, $p < .001$	Low Negative
Normalized Torque and Height	($r(15) = .671$, $p < .001$	Low Positive
Normalized Torque and Mass	($r(15) = .860$, $p < .001$	Moderate Positive
Arm Speed and Height	($r(15) = -.340$, $p = .007$	Low Negative
Arm Speed and Weight	($r(15) = -.682$, $p < .001$	Moderate Negative

Discussion

The purpose of this study was to assess the relationship between ankle dorsiflexion and plantarflexion, and normalized varus torque at the medial elbow of the throwing arm in collegiate baseball pitchers. Previous research has identified a decrease in ankle dorsiflexion in the back foot of pitchers as an independent risk factor for shoulder and elbow injuries [14]. There were significant positive correlations found between normalized varus torque during throwing and height and mass. However, there were no significant correlations found between normalized torque and dynamic or static ankle range of motion in the front or back foot. While these findings do not rule out decreased dorsiflexion as a risk factor for shoulder and elbow injuries in pitchers, they do suggest that an increase in varus elbow torque may not be the reason for this increase.

The authors theorized these lower measures in ankle range of motion may be indicative of a different causative issue. Considering that the largest correlation with normalized varus torque was found with increased mass, it is possible that musculoskeletal and cardiovascular fitness may play a role increased shoulder and elbow injury incidence in pitchers. Previous studies have indicated that increased fatigue and blood lactate levels have the potential to decrease musculoskeletal control during physical activity [16,17]. Decreased fitness may be related to decreased ankle dorsiflexion, thereby providing a causative link to increased risk of elbow and shoulder injuries in pitchers.

A possible limitation of this study was the relatively small sample size. A follow-up study involving a large subject population may allow for a more conclusive statement to be made on the effects of dynamic and static ankle dorsiflexion and plantarflexion on normalized varus torque at the medial elbow in pitchers. Further research should be done using validated patient and clinician-based outcomes measures to assess cardiovascular and musculoskeletal fitness in conjunction with measures of ankle range of motion and normalized varus torque at the medial elbow to better describe the relationship with these factors.

To the authors' knowledge, this is the first study conducted to assess the effects of dynamic and static ankle range of motion on normalized varus torque at the medial elbow in competitive baseball pitchers. Future research should look further into the effects of dynamic and static ankle range of motion on pitching mechanics and other factors that may predispose pitchers to shoulder and elbow injuries. Provided these studies use sound methodology, a more conclusive statement may be able to be made on the risk factors predisposing pitchers to shoulder and elbow injuries.

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