Scientific Research Publishing

Advances in Physical Education, 2019, 9, 1-7
http://www.scirp.org/journal/ape
ISSN Online: 2164-0408
ISSN Print: 2164-0386

Relationships between Shoulder Injuries during Throwing Motions and the Range of Motions in Junior and Senior High School Baseball Players

Tomoyuki Matsui[1,2], Toru Morihara[3], Machiko Hiramoto[1,2], Yoshikazu Azuma[1,2], Kazuya Seo[4], Yoshihiro Kai[5], Shuhei Morifusa[1], Teruo Nomura[2], Noriyuki Kida[2]

[1]Marutamachi Rehabilitation Clinic, Rakuwa Medical Sports, Kyoto, Japan
[2]Graduate School of Science and Technology, Kyoto Institute of Technology, Kyoto, Japan
[3]Department of Orthopedics, Graduate School of Medical Science, Kyoto Prefectural University of Medicine, Kyoto, Japan
[4]Rehabilitation Unit, University Hospital, Kyoto Prefectural University of Medicine, Kyoto, Japan
[5]Kyoto Tachibana University, Kyoto, Japan
Email: kida@kit.ac.jp

How to cite this paper: Matsui, T., Morihara, T., Hiramoto, M., Azuma, Y., Seo, K., Kai, Y., Morifusa, S., Nomura, T., & Kida, N. (2019). Relationships between Shoulder Injuries during Throwing Motions and the Range of Motions in Junior and Senior High School Baseball Players. *Advances in Physical Education, 9,* 1-7.
https://doi.org/10.4236/ape.2019.91001

Received: November 10, 2018
Accepted: December 22, 2018
Published: December 25, 2018

Abstract

The purpose of this study was to assess the range of motions of the upper and the lower limbs in junior and senior high school baseball players to examine relationships between the range of motions and shoulder injuries caused during throwing motions. Significant differences in the range of motion were not shown for any of the items between the injured and the healthy groups of junior or senior high school students. The height, weight, age, years of baseball experience, and the age of starting baseball indicated a significant difference only for the weight in the injured junior high school group ($p < .05$). Significant differences were not shown for any other variables. The possibility of the collapse of the kinetic chain among upper extremity, lower limbs, and the trunk increases when flexibility declines. Consequently, it was expected that throwing motions would place high stresses on the upper extremity, which causes pitching-related injuries. However, the results of this study did not indicate a correlation between the range of motions and shoulder injuries.

Keywords

Range of Motion, Baseball

1. Introduction

Throwing motions are performed by using every part of the human body. It has

been reported that the flexibility of the whole body including the lower limbs and the trunk is important for preventing pitching-related injuries (Hamada et al., 2009; Garrison et al., 2012). Shoulder injuries during throwing motions after epiphyseal closure often include symptoms of shoulder impingement syndrome (Morihara et al., 2013; Walch et al., 1992), which is a typical shoulder joint injury caused by throwing motions. It has been reported that impingement between the rotator cuff and the articular lip result from excessive external rotation and horizontal abduction of the shoulder joint (Burkhart & Morgan, 1998) during the late cocking phase of throwing motions. Keep throwing after repeated impingement causes tears of the rotator cuff and damage to the articular lip. Therefore, early detection and prevention are required.

It has been considered that the range of motions could be one of the causes of joint impingement syndrome. Comparing the range of motion between non-injured athletes and injured athletes has suggested that limited internal rotation of the shoulder joint might cause injuries to the shoulder and elbow joints (Shanley et al., 2011). Other studies have reported no correlation between internal and external rotation, or the horizontal adduction angle and injuries to the elbow (Sweitzer et al., 2012; Wilk et al., 2014). To date, there is no agreement on this issue.

This study assessed the range of motions of the upper and the lower limbs in junior and senior high school baseball players to examine relationships between the range of motions and shoulder injuries caused during throwing motions. Moreover, the effects of factors other than the range of motions, such as height, weight, age, years of baseball experience, and the age of starting baseball were taken into consideration.

2. Methods

2.1. Participants

Junior high school baseball players (N = 134, 34 pitchers, and 100 fielders) and senior high school baseball players (N = 309, 97 pitchers, and 212 fielders) that participated in a medical examination participated in the survey in off-season. The number of participants differed depending on the type of measurement.

2.2. Evaluating Pitching-Related Injuries

The Hyper External Rotational Test (HERT; Meister et al., 2004) was conducted by orthopedists to diagnose pitching-related injuries. Participants were classified into the shoulder joint impingement syndrome group and a control group based on the diagnosis. The player with pain of lower extremities and the lumbago excluded it from subject.

2.3. Evaluation of Physical Functions

The external and internal shoulder joint rotation angles (shoulder joint abduction to 90 degrees and the elbow joint flexion to 90 degrees), the shoulder joint

horizontal adduction angle, the external and internal the hip joint rotation angle (hip joint and knee joint flexion to 90 degrees), the heel buttock distance (HBD), and long seat type body anteflexion were used to assess the range of motions.

The assessment was conducted by four physical therapists, following the measurement methods adopted by the Japanese Association of Rehabilitation Medicine (The Japanese Orthopaedic Association Disability Committee, 1974) as well as the Kibler's method (Kibler et al., 1998). Among the four physical therapists, one fixed the body of a participant, one moved it, one measured the angles and distances, and one checked the axis of the goniometer and appearance of compensatory movements. The angle was measured using the Todai-type goniometer in degrees, and the distance was measured using the measuring tape in millimeters.

2.4. Analysis

First, the number and the percentage of injured players that participated in the medical check were identified. Next, differences in mean values in joint motions range, height, weight, age, years of baseball experience and age of starting baseball between the control and the injured groups were compared using an unpaired t-test. Before conducting this study, an explanation about the study was made to the participants and their parents, and their informed consent was obtained. Furthermore, the approval of the ethics committee of the Kyoto Prefectural University of Medicine was obtained in advance (approval number: RBMR-C1197-2).

3. Results

The number of baseball players diagnosed as having injuries among the 135 junior high school was nine (7.2%). On the other hand, 31 (10.0%) were positive to the throwing injuries test among 309 senior high school baseball players (**Table 1** & **Table 2**). Tests of the proportion of the population indicated a significant difference between the groups ($p < .05$).

Significant differences in the range of motion were not shown for any of the items between the injured and the healthy groups of junior or senior high school students. The height, weight, age, years of baseball experience, and the age of starting baseball indicated a significant difference only for the weight in the injured junior high school group. Significant differences were not shown for any other variables.

4. Discussion

The possibility of the collapse of the kinetic chain among upper extremity, lower limbs, and the trunk increases when flexibility declines. Consequently, it was expected that throwing motions would place high stresses on the upper extremity, which causes pitching-related injuries. However, the results of this study did not indicate a correlation between the range of motions and shoulder injuries.

Table 1. Physical functions of junior high school baseball players.

	Control group		Injured group		
	n	M ± SD	n	M ± SD	p
Age	125	13.3 ± 0.7	10	13.4 ± 0.7	.486
Years of baseball experience	125	3.9 ± 2.3	9	4.4 ± 2.1	.477
The age of starting baseball	125	9.4 ± 2.3	9	9.0 ± 2.2	.604
Height	125	160.2 ± 7.7	9	164.9 ± 7.4	.080
Weight	124	48.7 ± 7.6	9	55.6 ± 13.3	.014
Shoulder joint external rotation-throwing side	66	114.1 ± 9.9	3	115.0 ± 4.6	.873
Shoulder joint external rotation-not throwing side	66	112.7 ± 9.8	3	113.7 ± 2.9	.861
Shoulder joint internal rotation-throwing side	66	29.2 ± 10.4	3	34.0 ± 12.2	.441
Shoulder joint internal rotation-not throwing side	66	35.3 ± 10.2	3	34.0 ± 10.6	.831
Shoulder joint horizontal adduction-throwing side	66	100.9 ± 4.6	3	104.3 ± 3.2	.209
Shoulder joint horizontal adduction-not throwing side	66	107.9 ± 5.3	3	105.7 ± 1.2	.479
Hip joint external rotation-throwing side	66	59.3 ± 8.9	3	63.3 ± 10.7	.450
Hip joint external rotation-not throwing side	66	57.1 ± 9.1	3	62.7 ± 10.5	.307
Hip joint internal rotation-throwing side	66	29.8 ± 7.8	3	26.0 ± 8.7	.421
Hip joint internal rotation-not throwing side	66	27.6 ± 9.5	3	22.7 ± 9.3	.384
Heal buttock distance-throwing side	66	4.4 ± 4.8	3	5.3 ± 3.3	.740
Heal buttock distance-not throwing side	66	4.1 ± 4.7	3	3.5 ± 1.6	.825
Long seat type body anteflexion	66	41.2 ± 6.3	3	44.2 ± 8.1	.428

*$p < .05$.

The reasons for this could be as follows. Firstly, the maximum shoulder external rotation angle during pitching motion reaches 180 degrees (Diliman et al., 1991) and it requires high mobility. This angle is achieved by the involvement of the trunk and scapula, i.e. the glenohumeral joint (72.4%), scapular posterior tilt (17.2%), and thoracic spine extension (6.9%), among others (Miyashita et al., 2009). It is a complex movement that includes the trunk, and which cannot be achieved only by the glenohumeral joint. The throwing motion could be performed by compensatory movements of other joints if there is a restriction in the mobility of a single joint. Therefore, a correlation might not have been observed

Table 2. Physical functions of senior high school baseball players.

	Control group		Injured group		
	n	M ± SD	n	M ± SD	p
Age	272	16.2 ± 0.7	31	16.3 ± 0.6	.747
Years of baseball experience	270	7.7 ± 1.9	31	7.7 ± 2.5	.871
The age of starting baseball	270	8.5 ± 1.8	31	8.6 ± 2.3	.760
Height	272	172.1 ± 5.7	31	170.8 ± 4.5	.193
Weight	269	64.8 ± 7.2	31	62.7 ± 5.4	.120
Shoulder joint external rotation-throwing side	123	120.9 ± 11.7	8	117.5 ± 13.7	.435
Shoulder joint external rotation-not throwing side	123	116.4 ± 11.0	8	119.9 ± 8.0	.387
Shoulder joint internal rotation-throwing side	123	27.3 ± 11.0	8	24.8 ± 9.7	.533
Shoulder joint internal rotation-not throwing side	123	37.7 ± 12.2	8	44.8 ± 10.4	.114
Shoulder joint horizontal adduction-throwing side	122	98.9 ± 7.7	8	94.0 ± 7.8	.082
Shoulder joint horizontal adduction-not throwing side	123	107.4 ± 12.1	8	104.9 ± 3.6	.550
Hip joint external rotation-throwing side	72	59.7 ± 11.6	5	63.6 ± 10.6	.467
Hip joint external rotation-not throwing side	72	60.6 ± 9.8	5	66.8 ± 8.6	.172
Hip joint internal rotation-throwing side	72	33.4 ± 8.8	5	30.0 ± 9.3	.405
Hip joint internal rotation-not throwing side	72	33.1 ± 8.8	5	33.4 ± 10.8	.933
Heal buttock distance-throwing side	72	15.3 ± 4.4	5	13.6 ± 5.2	.419
Heal buttock distance-not throwing side	72	15.2 ± 4.5	5	14.8 ± 3.9	.863
Long seat type body anteflexion	100	45.9 ± 7.5	10	45.0 ± 13.0	.736

between the range of motions and shoulder injuries. Secondly, previous studies have indicated that muscle strength (Ellenbecker et al., 1997; Noffal, 2003), pitching forms (Whiteley, 2007; Matsuo et al., 2002), and energy transfer when using an appropriate kinetic chain (Setoguchi et al., 2008) are also important factors related to pitching-related injuries. Moreover, other factors such as height, types and the speed of pitches, and the training time might be related to pitching-related injuries. The mutual effects of the above factors and factors that have an antecedent effect are not clear. Moreover, causal relationships among these factors might interact in a complex manner (Matsui et al., 2014).

The above findings indicate the necessity to examine not only the range of motions in pitching-related injuries but also the causal relationships between

such injuries and physical functions. Moreover, complex factors in pitching-related injuries such as muscle strength must be considered from a comprehensive perspective that includes athletes' primary physical data and the degree and the content of training, among others. When they rehabilitated the shoulder injuries players, this study results thought that it was necessary to perform it in consideration of many elements including the muscular strength as well as flexibility. Furthermore, longitudinal studies are required to investigate the causal relationships in pitching-related injuries by considering the extent to which joint functions of the whole body in addition to the shoulder joint could be compensated, as well as the timing of injuries.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

Burkhart, S. S., & Morgan, C. D. (1998). The Peel-Back Mechanism: Its Role in Producing and Extending Posterior Type II SLAP Lesions and Its Effect on SLAP Repair Rehabilitation. *Arthroscopy, 14,* 637-640. https://doi.org/10.1016/S0749-8063(98)70065-9

Diliman, C. J., et al. (1991). *Biomechanics of the Shoulder in Sports: Throwing Activities.* Berryville, VA: Post Grad. Adv, Sports Med. Forum Medicum.

Ellenbecker, T. S., et al. (1997). Concentric Isokinetic Shoulder Internal and External Rotation Strength in Professional Baseball Pitchers. *Journal of Orthopaedic & Sports Physical Therapy, 25,* 323-328. https://doi.org/10.2519/jospt.1997.25.5.323

Garrison, J. C., et al. (2012). Shoulder Range of Motion Deficits in Baseball Players with an Ulnar Collateral Ligament Tear. *The American Journal of Sports Medicine, 40,* 2597-2603. https://doi.org/10.1177/0363546512459175

Hamada, J., et al. (2009). Longitudinal Survey on Shoulder/Elbow Injuries in High School Baseball Players. *The Shoulder Joint, 33,* 519-522.

Kibler, W. B., et al. (1989). A Musculoskeletal Approach to the Preparticipation Physical Examination Preventing Injury and Improving Performance. *The American Journal of Sports Medicine, 17,* 525-531. https://doi.org/10.1177/036354658901700413

Matsui, T., et al. (2014). New Evaluation Methods of Lower Limbs/Trunk Functions in Pitchers-Physical Characteristics of Injured Pitchers. *The Japanese Journal of Physical Fitness and Sports Medicine, 63,* 463-468. https://doi.org/10.7600/jspfsm.63.463

Matsuo, T., Matsumoto, T., Mochizuki, Y., Takada, Y., & Saito, K. (2002). Optimal shoulder Abduction Angles during Baseball Pitching Form Maximal Wrist Velocity and Minimal, Kinetics Viewpoints. *Journal of Applied Biomechanics, 18,* 306-320. https://doi.org/10.1123/jab.18.4.306

Meister, K., Buckley, B., & Batts, J. (2004). The Posterior Impingement Sign: Diagnosis of rotator Cuff and Posterior Labral Tears Secondary to Internal Impingement in Overhand Athletes. *American Journal of Orthopedics, 33,* 412-415.

Miyashita, K., Kobayashi, H., Koshida, S., & Urabe, Y. (2009). Analysis of External Rotation Movement of the Glenohumeral Joint and Scapular Posterior Tilting Movement in the Acceleration Phase during Pitching Motion. *Journal of Clinical Biomechanics, 30,* 395-400.

Morihara, T., et al. (2013). Prevention of Injuries for High School Baseball Players in

Kyoto-Support Provided at the Kyoto Tournament. *The Journal of Japanese Society of Clinical Sports Medicine, 21,* 176-186.

Noffal, G. J. (2003). Isokinetic Eccentric-to-Concentric Strength Ration of the Shoulder Rotator Muscles in Throwers and Non-Throwers. *The American Journal of Sports Medicine, 31,* 537-541. https://doi.org/10.1177/03635465030310041001

Setoguchi, Y., Sugimoto, K., Asai, Y., Shimada, T., Kudara, H., & Yamaguchi, N. (2008). Aftercare and Replace Prevention for Recurrent Dislocation of the Shoulder Joint of Athletes. *The Journal of Clinical Sports Medicine, 25,* No. 7.

Shanley, E., Rauh, M. J., Michener, L. A., Ellenbecker, T. S., Garrison, J. C., & Thigpen, C. A. (2011). Shoulder Range of Motion Measures as Risk Factors for Shoulder and Elbow Injuries in High School Softball and Baseball Players. *The American Journal of Sports Medicine, 39,* 1997-2006. https://doi.org/10.1177/0363546511408876

Sweitzer, B. A., Thigpen, C. A., Shanley, E., Stranges, G., Wienke, J. R., Storey, T., Noonan, T. J., Hawkins, R. J., & Wyland, D. J. (2012). A Comparison of Glenoid Morphology and Glenohumeral Range of Motion between Professional Baseball Pitchers with and without a History of SLAP Repair. *Arthroscopy, 28,* 1206-1213. https://doi.org/10.1016/j.arthro.2012.02.023

The Japanese Orthopaedic Association Disability Committee, The Japanese Association of Rehabilitation Medicine Evaluation Criteria Committee (1974). Indication of the Range of Motion and Measurement Methods. *The Japanese Journal of Rehabilitation Medicine, 11,* 127-132. https://doi.org/10.2490/jjrm1963.11.127

Walch, G., et al. (1992). Impingement of the Deep Surface of the Supraspinatus Tendon on the Posterosuperior Glenoid Rim. An Arthroscopic Study. *Journal of Shoulder and Elbow Surgery, 1,* 238-245. https://doi.org/10.1016/S1058-2746(09)80065-7

Whiteley, R. (2007). Baseball Throwing Mechanics as They Relate to Pathology and Performance—A Review. *Journal of Sports Science and Medicine, 6,* 1-20.

Wilk, K. E., Macrina, L. C., Fleisig, G. S., Aune, K. T., Porterfield, R. A., Harker, P., Evans, T. J., & Andrews, J. R. (2014). Deficits in Glenohumeral Passive Range of Motion Increase Risk of Elbow Injury in Professional Baseball Pitchers: A Prospective Study. *The American Journal of Sports Medicine, 42,* 2075-2081. https://doi.org/10.1177/0363546514538391