

ORIGINAL**Epidemiology of shoulder injuries in young baseball players and grading of radiologic findings of Little Leaguer's shoulder**

Yoshiji Kanematsu⁽¹⁾, Tetsuya Matsuura⁽²⁾, Shinji Kashiwaguchi⁽³⁾, Takenobu Iwase⁽⁴⁾, Naoto Suzue⁽²⁾, Toshiyuki Iwame⁽⁵⁾, Shoji Fukuta⁽⁶⁾, Daisuke Hamada⁽¹⁾, Tomohiro Goto⁽¹⁾, and Koichi Saiyo⁽¹⁾

⁽¹⁾ Department of Orthopaedic Surgery, Tamaki Aozora Hospital, Tokushima, Japan, ⁽²⁾ Department of Orthopedics, Tokushima University, Tokushima, Japan, ⁽³⁾ Department of Orthopaedic Surgery, Japan Community Health Care Organization, Tokyo Shinjuku Medical Center, Tokyo, Japan, ⁽⁴⁾ Department of Orthopaedic Surgery, Tokushima National Hospital, Tokushima, Japan, ⁽⁵⁾ Department of Orthopaedic Surgery, Tokushima Prefectural Central Hospital, Tokushima, Japan, ⁽⁶⁾ Department of Orthopaedic Surgery, Kochi Health Science Center, Kochi, Japan

Abstract : Relatively few epidemiological studies have examined shoulder injuries. This study aimed to investigate the epidemiology of such injuries in young baseball players. A total of 2,055 players aged 9-12 years who participated in a regional championship between 1983 and 1985 were the subjects of this investigation. They were assessed by questionnaire and radiographic examination. Prevalence of shoulder pain was determined according to position, years of baseball playing experience, and training hours per week. Radiographic examination was recommended to all players who complained of shoulder pain. Of the 2,055 subjects, 275 (13.4%) reported episodes of pain in the throwing shoulder. Years of baseball experience, but not player position or training hours per week, was significantly associated with shoulder pain. Forty-one of the 275 subjects reporting shoulder pain agreed to undergo radiography and 15 exhibited findings of Little Leaguer's shoulder. Their lesions could be classified into three distinct grades based on radiographic findings : grade I, widening of the epiphyseal plate in the lateral area (n=9) ; grade II, widening at all areas of the epiphyseal plate and demineralization of the metaphysis (n=5) ; and grade III, a slipped epiphysis (n=1). *J. Med. Invest.* 62 : 123-125, August, 2015

Keywords : shoulder, baseball, epidemiology

INTRODUCTION

Baseball players are typically at increased risk for shoulder injuries. One of the most common of these is overuse injury to the throwing arm, believed to result from cumulative microtrauma caused by the repetitive, dynamic, overhead throwing motion (1, 2). However, the factors associated with these injuries are poorly understood and have been studied only infrequently (3-7). Existing studies investigating throwing-related problems have been typically done from a biomechanical perspective and had small sample sizes (8-12). Of the relatively few epidemiological studies that have examined shoulder injuries, only a small number have examined the prevalence of shoulder pain among young players. The incidence rate for shoulder pain has been reported as 29% among 9- to 19-year-old boys (7) and similarly 32% and 35% (13, 14), but all players were pitchers and only those from local leagues. The prevalence among catchers, infielders, or outfielders who do not pitch remains unclear.

This study aimed to investigate the epidemiology of shoulder injuries in young baseball players across all playing positions and competing at regional level.

MATERIALS AND METHODS

This study was approved by the Institutional Review Board of

Received for publication December 5, 2014 ; accepted December 22, 2014.

Address correspondence and reprint requests to Tetsuya Matsuura, MD, PhD, Associate Professor, Department of Orthopedics, Tokushima University 3-18-15 Kuramoto, Tokushima 770-8503, Japan and FAX : +81-88-633-0178.

Tokushima University Hospital, and all parents and coaches provided informed consent.

A total of 2,055 players aged 9-12 years who participated in the regional baseball championship between 1983 and 1985 were the subjects of this investigation. Subjects were assessed by questionnaire and radiographic examination. None of the pitchers in this study had thrown curveballs or sliders ; all had thrown fastballs or change-ups.

Questionnaires were distributed to the team coaches, and information was filled out by the subjects with the assistance of coaches or parents. Subjects were asked whether they had experienced any episodes of shoulder pain. The questionnaire also gathered data regarding player position, years of baseball experience, and training hours per week. The senior author (T.I.) subsequently reviewed the questionnaire with each subject to ensure their understanding of the questions and check the accuracy of the information provided.

The prevalence of shoulder pain was calculated according to playing position, years of baseball experience, and training hours per week and expressed as a percentage. The chi-square test was used to determine whether the prevalence rates differed according to these three factors. All tests were two-sided and significance was set at $P < 0.05$.

Radiographic examination was recommended to players who complained of shoulder pain. External rotation anteroposterior radiographs of both shoulders were taken and reviewed by two of the authors (Y.K. and T.I.). Little Leaguer's shoulder was defined as a greater width of the proximal humeral physis in the throwing arm than that in the unaffected shoulder.

RESULTS

Of the 2,055 subjects, 275 (13.4%) reported episodes of pain in the throwing shoulder. Tables 1, 2, and 3 show the occurrence of shoulder pain by position, years of baseball experience, and training hours per week, respectively. Years of baseball experience was significantly associated with shoulder pain ($P < 0.05$), while player positions and training hours per week showed no significant associations ($P = 0.132$ for player position and $P = 0.094$ for training hours per week).

Table 1. Shoulder pain by young baseball player position

Position	No. of participants	Shoulder pain, n (%)
Pitcher	268	45 (16.8)
Catcher	210	34 (16.2)
Infielder	817	105 (12.9)
Outfielder	760	91 (12.0)

Table 2. Shoulder pain by years of baseball experience

Years of experience	No. of participants	Shoulder pain, n (%)
< 1	437	45 (10.3)
≥ 1	1618	230 (14.2)

Table 3. Shoulder pain by training hours per week

Training hours	No. of participants	Shoulder pain, n (%)
< 14	789	93 (11.8)
≥ 14	1266	182 (14.4)

Forty-one of the 275 subjects with a history of pain (14.9%) agreed to undergo radiography, 15 (36.6%) of whom had findings of Little Leaguer's shoulder on radiography. Theirs lesions were classified into three distinct grades based on the radiographic findings (Figure 1): grade I was characterized as widening of the epiphyseal plate seen only in the lateral area ($n = 9$); grade II was characterized as widening at all areas of the epiphyseal plate and demineralization of the metaphysis ($n = 5$); and grade III was a slipped epiphysis ($n = 1$).

DISCUSSION

This is the first study to report the epidemiological findings of shoulder pain for entire teams of young baseball players. The frequency of shoulder pain in these young players was 13.4%. Shoulder pain was significantly associated with a greater number of years of baseball experience. From the subjects with shoulder pain who agreed to undergo radiography, 36.6% showed Little Leaguer's shoulder, and based on their radiographic findings, we were able to classify Little Leaguer's shoulder into 3 grades.

Relatively few epidemiological studies have examined the risk factors associated with increased throwing-related arm problems and injuries (10), but many throwing-related injuries in baseball are believed to result from cumulative microtrauma due to the repetitive throwing motion used (15). It is hypothesized that large numbers of throws made and limited recovery times lead to arm fatigue, which therefore means those individuals playing as a pitcher, having a long playing career, and practicing for many hours are at greater risk of shoulder problems and subsequently have an increased risk for arm injuries. Interestingly, in this study, this theory was shown to hold true for years of baseball experience but not for player position or training hours per week.

Compared with adult athletes, young athletes still undergoing skeletal development have unique issues with respect to injury patterns. Poor technique or mechanics that increase loads across the physis make the skeletally immature developing athlete prone to injury. The epiphyseal plates of the shoulder, which usually begin to ossify between 2 and 11 years of age and do not completely ossify until the late teens, are weaker than the surrounding joint capsule and ligaments (16). The combination of weaker epiphyseal plates and excessive laxity of the supporting structures in the shoulder region plus repetitive throwing motions may lead to greater risk of Little Leaguer's shoulder in young baseball players (17). In our study, 15 (36.6%) of the young players examined by radiography exhibited Little Leaguer's shoulder, a syndrome involving the proximal humeral epiphyseal plate (18). The classic radiographic finding in Little Leaguer's shoulder is widening of the proximal humeral physis, and often other chronic changes are evident, such as demineralization, sclerosis, and fragmentation. This seems to indicate a gradual microtrauma type of mechanism of injury, as compared with the trauma of an acute fracture. The recommended treatment for this condition consists of rest and physical therapy (19), and in a previous study we reported that



Figure 1. Radiographic classification of Little Leaguer's shoulder. (A) Grade I: widening of the epiphyseal plate only in the lateral area. (B) Grade II, widening in all the areas of the epiphyseal plate and demineralization of the metaphysis. (C) Grade III, a slipped epiphysis.

the healing process in Little Leaguer's shoulder began medially and advanced laterally. Healing was achieved in approximately 5 months after the initial examination, with no recurrence of pain or other symptoms (20). Taken together with the findings in the present study, we were able to classify Little Leaguer's shoulder into three distinct grades based on the radiographic findings. The use of this classification system may be useful in current efforts to clarify the pathomechanism of Little Leaguer's shoulder ; further larger scale studies are first needed to verify the present results.

This study provides new data on epidemiology of shoulder injuries in young baseball players. However, there are several limitations to the study. One major limitation is that our data are based on self-reporting by young participants (some as young as 9 years old). There may have been some recall bias when they were asked about their history of shoulder pain. Another limitation is that other potential risk factors were not examined in this study, such as skeletal age, pitching mechanics, and physical conditioning.

CONCLUSION

Among more than 2000 baseball players aged 9-12 years, 13.4% reported episodes of shoulder pain. Shoulder pain was associated only with years of baseball experience. Of the 41 players who agreed to undergo radiography, 15 exhibited radiographic findings of Little Leaguer's shoulder, which we classified into three distinct grades.

CONFLICTS OF INTEREST

None of the authors received any funding support to complete this report. None of the authors have any conflicts of interest to declare.

REFERENCES

1. Andrews JR, Fleisig GS : Preventing throwing injuries. *J Orthop Sports Phys Ther* 27 : 187-188, 1998
2. Grana W, Rashkin A : Pitcher's elbow in adolescents. *Am J Sports Med* 8 : 333-336, 1980
3. Adams JE : Injury to the throwing arm : A study of traumatic changes in the elbow joints of boy baseball players. *Calif Med* 102 : 127-132, 1965
4. Gugenheim JJ, Stanley RF, Woods GW, Tullos HS : Little League survey : the Houston study. *Am J Sports Med* 4(5) : 189-200, 1976
5. Larson RL, Singer KM, Bergstrom R, Thomas S : Little League survey : the Eugene study. *Am J Sports Med* 4(5) : 201-209, 1976
6. Pasternack JS, Veenema KR, Callahan CM : Baseball injuries : A Little League survey. *Pediatrics* 98 : 445-448, 1996
7. Torg JS, Pollack H, Sweterlitsch P : The effect of competitive pitching on the shoulders and elbows of preadolescent baseball players. *Pediatrics* 49 : 267-272, 1972
8. Davis JT, Limpisvasti O, Fluhme D, Mohr KJ, Yocum LA, Elattrache NS, Jobe FW : The effect of pitching biomechanics on the upper extremity in youth and adolescent baseball pitchers. *Am J Sports Med* 37(8) : 1484-1491, 2009
9. Dun S, Loftice J, Fleisig GS, Kingsley D, Andrews JR : A biomechanical comparison of youth baseball pitchers : is the curveball potentially harmful? *Am J Sports Med* 36 : 686-692, 2006
10. Fleisig GS, Andrews JA, Cutter GR, Weber A, Loftice J, McMichael C, Hassell N, Lyman S : Risk of serious injury for young baseball pitcher : a 10-year prospective study. *Am J Sports Med* 39 : 253-257, 2011
11. Nissen CW, Westwell M, Ounpuu S, Patel M, Solornito M, Tate J : A biomechanical comparison of the fastball and curveball in adolescent baseball pitchers. *Am J Sports Med* 37 : 1492-1498, 2009
12. Trakis JE, McHugh MP, Caracciolo PA, Busciacchio L, Mullaney M, Nicholas SJ : Muscle strength and range of motion in adolescent pitchers with throwing-related pain : implications for injury prevention. *Am J Sports Med* 36(11) : 2173-2178, 2008
13. Lyman S, Fleisig GS, Andrews JR, Osinski ED : Effect of pitch type, pitch count, and pitching mechanics on risk of elbow and shoulder pain in youth baseball pitchers. *Am J Sports Med* 30 : 463-468, 2002
14. Lyman S, Fleisig GS, Waterbor JW, Funkhouser EM, Pulley L, Andrews JR, Osinski ED, Roseman JM : Longitudinal study of elbow and shoulder pain in youth baseball pitchers. *Med Sci Sports Exerc* 33(11) : 1803-1810, 2001
15. Olsen SJ II, Fleisig GS, Dun S, Loftice J, Andrews JR : Risk factors for shoulder and elbow injuries in adolescent baseball pitchers. *Am J Sports Med* 34 : 905-912, 2006
16. Sabick MB, Kim YK, Torry MR, Keirns MA, Hawkins RJ : Biomechanics of the shoulder in youth baseball pitchers : implications for the development proximal humeral epiphysis and humeral retrotorsion. *Am J Sports Med* 33 : 1716-1722, 2005
17. Walton J, Paxinos A, Tzannes A, Callanan M, Hayes K, Murrell GA : The unstable shoulder in the adolescent athlete. *Am J Sports Med* 30 : 758-767, 2002
18. Dotter WE : Little Leaguer's Shoulder. *Guthrie Clin Bull* 23 : 68, 1953
19. Taylor DC, Krasinski KL : Adolescent shoulder injuries : Consensus and controversies. *J Bone Joint Surg* 91A : 462-473, 2009
20. Kanematsu Y, Matsuura T, Kashiwaguchi S, Iwase T, Suzue N, Iwame T, Sairyō K : Radiographic follow-up study of Little Leaguer's shoulder. *Skeletal Radiol* 44 : 73-76, 2015