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CLINICAL FEATURE
ORIGINAL RESEARCH

Prevalence and patterns of shoulder injuries in Major League Baseball

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ABSTRACT

Background: This study aims to explore the epidemiological patterns of shoulder injuries in professional baseball.

Methods: The transaction lists of the 'Major League Baseball' website were screened for injuries from 2011 to 2016, inclusive. Only players that were placed on the 'Disabled List' were included in the study. Our database included the player's position, injury location, injury cause, and time spent on the Disabled List.

Results: A total of 3090 injuries were recorded; 511 (17%) were shoulder injuries, making it the most vulnerable anatomic location in baseball (N = 511). Of the 511 shoulder injuries, 132 (25.8%) were due to inflammation, making it the most common cited cause of shoulder injury. Most shoulder injuries occurred in April with 125 (24%) injuries, while June and May came in second and third with 89 (17%) and 81 (16%) injuries, respectively. The pitcher was the player most prone to injury, as it constituted 78% of the injuries. The average time spent off by a shoulder injury was 69 days, which implicated substantial economic losses for the injured athlete's club.

Conclusion: Shoulder injuries are prevalent in professional baseball. The overhead pitching motion puts the shoulder at risk and accounts for the high incidence of its injuries.

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KEYWORDS
Shoulder injuries; baseball; sports; pitcher; Major League Baseball

Introduction

Shoulder injuries are common in many contact and non-contact sports [1]. Sports that involve throwing motions have their athletes more susceptible to this type of injury [2,3]. These injuries are often debilitating knowing that there is more movement in the shoulder joint than in any other joint in the body [4]. Shoulder injuries often lead to significant hindrance in shoulder movement, a general lack of stability in the throwing athlete [4], and musculoskeletal pain [5–7].

Baseball is a sport that is frequently affected by shoulder injuries. The sport often includes high speed throwing motions, which may reach rotational velocities of 7000 °/sec [4,8]. This puts pressure on the dynamic stabilizing structures of the shoulder, making it more vulnerable to injury [4,8]. Shoulder injuries are specifically influential in baseball because they require a lengthy healing time and often prevent the players from returning to their pre-injury performance levels [3]. As a result, players are sidelined for long durations and retirement considerations are often made.

The aim of this study is to explore the epidemiological patterns of shoulder injuries in baseball using data from the 'Disabled List' (DL) in 'Major League Baseball.' Understanding the characteristics of shoulder injuries will allow better analysis of the biomechanics of the injuries and formulation of better prevention policies.

Materials and methods

Study design

Major League Baseball (MLB) is a baseball league comprised of 30 different clubs that span over the United States and Canada. Each club has 163 games scheduled over a six-month season. One season usually begins at late March or early April and ends on the first week of October [9]. MLB players that are injured are placed on the MLB's DL. The data was compiled using the transaction database in the MLB website [10].

Participants

Only players that were added to the DL between 2011 and 2016 (inclusive) were included in this study. MLB rules dictate that the player must be diagnosed by the team physician and certified as incapable to play in order to be placed on the DL [11,12]. Players can remain on the list for as much time as they need to fully recover from their injuries; however, once placed on the list, the player must remain inactive for a minimum of 15 days [11].

Definitions

Baseball constitutes several playing positions. The pitcher is the player who throws the baseball from the pitcher's mound toward the catcher, the receiver of the ball, to begin each play.

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An infielder player is stationed at one of four defensive 'infield' positions on the baseball field (first base, second base, third base or shortstop). An outfielder is a player who tries to catch long fly balls before they hit the ground or to quickly catch or retrieve and return to the infield any other balls entering the outfield. Outfielders normally play behind the infielders.

Any injury that included the terms: 'shoulder,' 'rotator cuff,' 'AC joint,' 'labrum,' and/or 'biceps tendinitis', and placed the player on the DL for a minimum of 15 days was considered a shoulder injury [11].

Data processing

Data pertaining to the player's position (pitcher, catcher, infielder, outfielder); anatomic position of injury (shoulder, elbow, oblique, back, knee, hamstring, other injuries); cited cause of injury (tendinitis, inflammation, strain, other); the time spent on the DL (0–-30 days, 30–90 days, >90 days); and whether the injury required surgery were collected. We defined a strain injury as an overstretched or pulled shoulder muscle due to exhaustion or depletion, tendinitis as an injury to the biceps tendon or a tendon in the shoulder's rotator cuff, inflammation as an injury that causes swelling of the bursa between the shoulder blade and the rotator cuff (i.e. bursitis), and surgery requiring injuries as those injuries that necessitated a surgical intervention for full recovery. Injuries that were cited due to other causes were labelled as 'other'. Injuries listed were the ones that occurred during training, regular season, or post-season play, and caused a loss in game time for the player. Injuries during off-season were not included since they do not relate to baseball activity.

Results

Injury incidence by anatomic position

A total of 3090 injuries were documented during the study period. Of which, 511 shoulder injuries were recorded (17%), making the shoulder the most vulnerable anatomic position to injury in professional baseball (N = 511). Elbow and hamstring injuries were found to be second and third with 437 (14%) and 225 (7%) injuries, respectively (Table 1).

Injury type

Of the 511 shoulder-related issues for which the player was placed on the DL, 132 were due to inflammation (25.8%), making it the most common cause of shoulder injuries in the MLB. Strain followed with 124 injuries (24.2%), and tendinitis with 67 injuries (13%). Of the 517 shoulder injuries, 48 required surgery (9.3%) (Table 2).

Table 1. Distribution of injuries in Major League Baseball by anatomic position (2011–2016).

	Shoulder	Elbow	Oblique	Back	Knee	Hamstring	Other injuries	Total
2011	94	59	42	35	24	26	228	508
2012	78	77	27	34	37	30	210	493
2013	86	80	29	25	35	38	236	529
2014	66	71	24	21	30	48	217	477
2015	93	67	22	28	36	27	237	510
2016	94	83	29	36	40	56	235	573
Total	511	437	173	179	202	225	1363	3090

Table 2. Distribution of shoulder injuries in Major League Baseball by type of injury (2011–2016).

	Tendinitis	Surgery	Inflammation	Strain	Other	Total
2011	16	10	22	22	24	94
2012	8	5	16	19	30	78
2013	10	12	18	21	25	86
2014	10	6	22	14	14	66
2015	13	8	29	24	19	93
2016	10	7	25	24	28	94
Total	67	48	132	124	140	511

Time loss

To assess the healing time of shoulder injuries, we studied the time that injured athletes spent on the DL during the six seasons (Table 3). The average time spent on the DL was calculated to be 69 days. Time spent on the DL varied between 30–90 days (37%), less than 30 days (33%) and more than 90 days (30%). Average time spent based on diagnosis varied between 67 days for inflammation, 62 days for tendinitis, and 60 days for strain. Overall, non-surgical reasons placed the injured athlete on the DL for an average of 65 days. On the other hand, injuries that required surgery placed the injured athlete on the DL for an average of 112 days.

Injury by position

Pitchers constituted the position with the most frequent shoulder injuries in the game with 77% of the injuries. Outfielders and Infielders came in second and third with 11% and 9% injury prevalence, respectively, while catchers came in last at 3% (Table 4).

Injury by month

The 511 injuries were spread along the months of March–September, whereas October–February witnessed no injuries (Figure 1). April was shown to be the month of the most injuries with 125 (24%) injuries, while June and May came in second and third with 89 (17%) and 81 (16%) injuries, respectively. Injuries that required surgery were highest during the months of March and April with 24 (50%) and 17 injuries (35%) respectively (Figure 2). Moreover, we calculated the average number of days the athlete was placed on DL due to shoulder injury by month (Figure 3). A decreasing trend is evident showing March and April to be the months with the highest number of days issued on the DL (97 days and 92 days respectively), whereas August and September showed the lowest number of days issued on the DL (26 days and 31 days respectively).

Table 3. Classification of shoulder injuries in Major League Baseball by days placed on DL (2011–2016).

	Shoulder Injuries	0–30 days Injuries	30–90 days Injuries	>90 days Injuries	Average days on DL
2011	94	29	33	32	74
2012	78	27	25	26	80
2013	86	32	28	26	68
2014	66	22	25	19	58
2015	93	30	41	22	61
2016	94	30	35	29	71
Total	511	170	187	154	69

Table 4. Distribution of shoulder injuries by playing position in Major League Baseball (2011–2016).

	Inflammation	Strain	Tendinitis	Surgery	Other	Total
Pitcher	118	99	65	29	84	395
Outfielder	9	11	0	7	30	57
Infielder	3	11	0	9	22	45
Catcher	2	3	2	3	4	14
Total	132	124	67	48	140	511

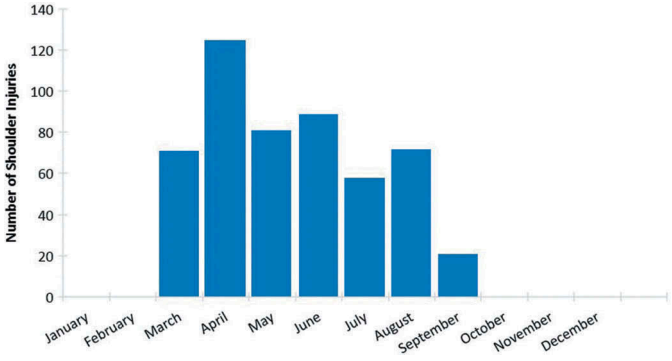

Figure 1. Distribution of shoulder injuries by month in Major League Baseball (2011–2016).

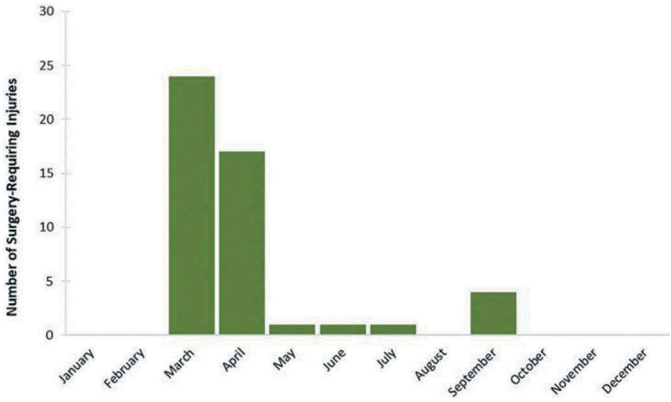

Figure 2. Distribution of Surgery-Requiring Injuries by Months.

Discussion

Our study shows that baseball, a major throwing sport, is frequently impacted by shoulder injuries every season. We found that the shoulder was the most vulnerable anatomic location in baseball players. Nevertheless, shoulder injuries occur frequently in other overhead sports. In American football, the throwing motion for the quarterback involve phases that are like that of baseball; however, the extra weight of the football changes the shoulder's positions and stresses in all stages. Also, football quarterbacks do not throw at the same speeds. Maximal external rotation is achieved earlier with quarterbacks giving more time for acceleration during internal rotation [13]. In addition, increased elbow flexion and horizontal abduction of the arm decreases the impact of the heavier football, which decreases the stress subjected on the shoulder. This accounts for the lower prevalence of shoulder injuries in football (12%) when compared to baseball (18%) in U.S. high school athletes [14,15]. This would also explain the traumatic nature of shoulder injuries in football as opposed to the overuse

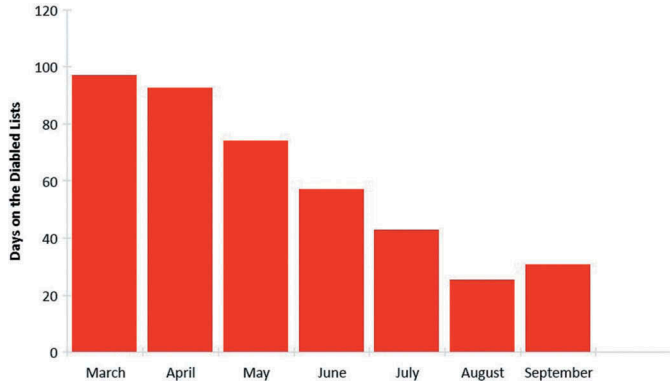

Figure 3. Average days on DL by month in Major League Baseball (2011–2016).

nature of shoulder injuries in baseball [13,14,16]. In tennis, the overhead serve utilizes muscle functions and motion patterns that are like the baseball pitch, and accordingly, stress residing on the shoulder is similar [17]. In swimming, the pull phase of the arm is equivalent to the acceleration phase of the baseball pitch; however, the pull phase is slower and thus induces less damage to the shoulder [18].

April proved to be the month with the most injuries in general, and March proved to be the month with the most surgery-requiring injuries. The MLB season is divided into 3 periods: spring training (mid-February – March), regular season (late March – early September), and post season (October) [9]. The regular season starts at the end of March, after the spring training ends. We believe that the prevalence of shoulder injuries at the beginning of the regular season could be associated with increasing stress, exhaustion and increasing exertions during performances. Studies on training loads and injury prevention suggested that high intensity training is not the cause of increased injuries, but rather the excessive and rapid increase in training loads [19]. The abrupt change from the relatively non-critical spring training to the more crucial regular season contributes to these factors. Our results fall in accordance with other studies, which noted that the highest musculoskeletal injury rates, and most of the surgery-requiring injuries in MLB have been recorded during the months of March and April [9,11]. Heightened playing efforts, improper conditioning, lack of flexibility, and fatigue have all been cited as possible factors that may attribute to high injury rates during this period [16,17]. Moreover, injuries during the season followed a decreasing trend with respect to days spent on DL. The beginning of the season (late March and April) showed injuries with an average of 95 days on DL. This decreased to an average of 28 days on DL at late season (August and September). Several reasons may account to this finding. We mentioned that the fact that abrupt change in pace of training and activity during the beginning of the season leads to a higher number of injuries. This critical change in pace and training could also induce more deleterious injuries that require longer recovery times. In addition, there may be increasing efforts later in the season to reduce the player's time spent on the DL, in an attempt to regain their full services during the play-offs. This would explain the trend observed in our results.

The average time spent off by a shoulder injury was 69 days, showing indeed that shoulder injuries are debilitating and require a lengthy healing time. Since the shoulder has the largest range of motion in the body, it is often prone to a wide spectrum of injuries with variable characteristics [18,20]. Some are mild and require non-operative treatment with short healing times, like muscle aches and strains; others, however, are severe and require surgery with lengthy healing times, like rotator cuff tears and dislocations [21]. Our study characterized shoulder injuries by ways of time loss. Shoulder injuries that sidelined the player for less than or equal to 30 days were considered mild, 30–60 days were considered intermediate, and more than 90 days were considered severe. Shoulder injuries were almost equally distributed between these three categories. This serves to further delineate the wide spectrum of shoulder injuries occurring in the throwing athlete. We believe that the overhead throwing motion can entice multiple types of shouder injuries with varying severity. This highlights the importance of understanding the biomechanics and kinematics of the throwing motion [22], and the need for further research on similar injuries in the future [23–25].

Shoulder injuries also proved to be debilitating on an economic perspective. In Major League Baseball, the average annual salary of a baseball player in 2017 was found to be 4.47 million USD [26]. Days spent on the DL mean player inactivity, and subsequently account for massive losses of money. An average shoulder injury places the athlete on the DL for 69 days, which accounts for approximately a third of the MLB season. This means that the average shoulder injury costs the player's club around 1.48 million USD in playing time per season. Given the high frequency of shoulder injuries in baseball, this delineates the burdening economic effect shoulder injuries have on MLB clubs.

The pitching position was the playing position most prone to injury. The involvement of strong throwing motions in pitchers may have contributed to this result. Studies show that continuous top-performance of overhead athletes can place great stress on the throwing shoulder, and as a result, subject it to overuse injuries [27]. Pitchers can reach dangerously high rotational speeds with their arms when throwing, as well as acquire huge joint distraction forces and compression [27]. This in turn, puts the shoulder region at great risk of injury and explains the prevalence of inflammation and tendinitis in baseball shoulder injuries.

To our knowledge, this article is among the first to exclusively explore the patterns and trends of shoulder injuries in Major League Baseball. Nevertheless, a few limitations exist. In order to be placed on the DL, the athlete must remain inactive for a minimum of 15 days. This skews the average of days spent on the DL for the injured athlete positively. In addition, surgery-requiring injuries did not cite the type of surgery performed, which could have overlapped with other cited reasons for shoulder injuries.

Conclusion

The findings of this study offer a framework for sports physicians and a basis for further research in the prevention of shoulder injuries in professional baseball. Shoulder injuries are the cause of most injuries in baseball. Pitchers are the most vulnerable, and the most often cited cause of injury is inflammation. The beginning of the regular season was the period with the most injuries in Major League Baseball and the time loss for players ranged according to the severity of the injury.

This study implies the need for prevention strategies like certain breaks or better spacing of competitive games early in the season. Players, especially pitchers, need to be protected and assessed more frequently by sports physicians during the season to detect early signs of inflammation and tendinitis. Understanding the epidemiological patterns of shoulder injuries will allow better analysis of the biomechanics of the injuries and formulation of better prevention policies in the future.

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Declaration of interest

PSM peer reviewers on this manuscript have no conflicts of interest to disclose.

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