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Epidemiology and Impact of Abdominal Oblique Injuries in Major and Minor League Baseball

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Background: Oblique injuries are known to be a common cause of time out of play for professional baseball players, and prior work has suggested that injury rates may be on the rise in Major League Baseball (MLB).

Purpose: To better understand the current incidence of oblique injuries, determine their impact based on time out of play, and to identify common injury patterns that may guide future injury prevention programs.

Study Design: Descriptive epidemiological study.

Methods: Using the MLB Health and Injury Tracking System, all oblique injuries that resulted in time out of play in MLB and Minor League Baseball (MiLB) during the 2011 to 2015 seasons were identified. Player demographics such as age, position/role, and handedness were included. Injury-specific factors analyzed included the following: date of injury, timing during season, days missed, mechanism, side, treatment, and reinjury status.

Results: A total of 996 oblique injuries occurred in 259 (26%) MLB and 737 (74%) MiLB players. Although the injury rate was steady in MiLB, the MLB injury rate declined ($P = .037$). A total of 22,064 days were missed at a mean rate of 4413 days per season and 22.2 days per injury. The majority of these occurred during batting ($n = 455$, 46%) or pitching ($n = 348$, 35%), with pitchers losing 5 days more per injury than batters ($P < .001$). The leading side was injured in 77% of cases and took 5 days longer to recover from than trailing side injuries ($P = .009$). Seventy-nine (7.9%) players received either a corticosteroid or platelet-rich plasma injection, and the mean recovery time was 11 days longer compared with those who did not receive an injection ($P < .001$).

Conclusion: Although the rate of abdominal oblique injuries is on the decline in MLB, this is not the case for MiLB, and these injuries continue to represent a significant source of time out of play in professional baseball. The vast majority of injuries occur on the lead side, and these injuries result in the greatest amount time out of play. The benefit of injections for the treatment of oblique injuries remains unknown.

Keywords: Major League Baseball; Minor League Baseball; professional baseball; oblique

Core abdominal musculature plays a critical role in nearly every baseball-related movement as it is heavily utilized for maintenance of posture, throwing, swinging, twisting, pivoting, running, and jumping activities.^{3,7,13,17,20} These muscles, especially the internal and external obliques, help transfer forces along the kinetic chain from the lower extremities to the upper extremities.⁹ Accordingly, they are a common source of injury and time out of play in multiple sports, including professional baseball.^{3,6,10} Of all the core muscles (internal and external oblique, rectus and transversus abdominis), the obliques are the most commonly injured during baseball-related activities.³ They are responsible for 4% to 5% of all injuries occurring

in Major League Baseball (MLB), and they typically present with the acute onset of sharp pain over the lateral abdomen after a forceful rotational activity such as pitching, batting, diving, or throwing.^{3,15} Examination may reveal localized tenderness to palpation with decreased rotational motion and strength.

The most comprehensive report of oblique strains in MLB players to date was published in 2012.³ This study utilized publically available disabled list (DL) data spanning the 1991 to 2010 MLB seasons. Over the course of those 20 seasons, a total of 393 abdominal strains resulted in a mean 30.6 days out of play per injury.³ The contralateral or leading side (opposite side of throwing arm or batting side) was injured in over 70% of cases, and 12% of players experienced recurrence of injury after attempting to return to play.³ As a result of this work, increased attention has been paid to these injuries, and additional focus is

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being placed on preemptive core strengthening as a potential means to prevent injury. Although this work was extremely informative, it relied on publically available data from DL reports that are not without their limitations. Mainly, DL data may potentially underreport injury rates and incidences, does not allow inclusion of minor league players, and does not provide enough information to allow for proper identification of specific patterns of injury.

Fortunately, many of these limitations can now be overcome due to the creation and implementation of the Health and Injury Tracking System (HITS) by MLB beginning with the 2010 season.¹⁴ This database permits a much more robust analysis of this commonly occurring injury than what has previously been reported. Injury data are entered by the athletic trainers and medical professionals caring for MLB and Minor League Baseball (MiLB) teams. The purpose of this work was to utilize the HITS database to provide an updated report on the epidemiology and impact of oblique injuries in MLB and MiLB. Specifically, we seek to (1) better understand the true incidence and rates of oblique injuries in this elite athletic population, (2) determine the impact of these injuries based on time out of play, and (3) use these data to identify specific injury patterns and at-risk athletes to lay a foundation for potential injury prevention programs in the future. We hypothesize that the incidence of oblique strains is on the decline given the focused injury prevention efforts in recent years, but these injuries likely continue to represent a significant cause for time out of play in professional baseball players.

METHODS

After approval by an institutional review board and the MLB Research Committee, deidentified data were retrieved from the MLB HITS medical record system on all MLB and MiLB players who had sustained abdominal wall or core muscle injuries that resulted in time out of play during the 2011 to 2015 seasons. The HITS database was created, approved, and implemented through a joint effort of MLB and the MLB Players Association (MLBPA) in 2010.¹⁴ The overarching purpose of this electronic medical record (EMR) was to allow accurate, reliable, and consistent tracking of injuries occurring to all MLB and MiLB players to better understand how players were being injured, how they were treated, and how these injuries affected their play. Additional details on the HITS database have been published elsewhere.^{1,5,8,14}

Initially, all possible types of abdominal and core muscle injuries were identified. These included any injury with one of the following sports medicine diagnostic codes: oblique strain, intercostal muscle strain, abdominal wall strain, or abdominal stitch/diaphragmatic hernia. To be included in the analysis, injuries had to result in a minimum of 1 day out of play. Season-ending injuries were excluded because these do not allow accurate assessment of recovery since the athlete cannot technically “return to play” until the following season and it is difficult to know whether the athlete may have fully recovered during the off-season. Only injuries occurring during spring training, the regular season, or the postseason were included. For each injury, a multitude of variables were analyzed, including date of injury, time of season, days missed (DM), activity leading to injury, location on the field, mechanism, body side, chronicity, utilization of magnetic resonance imaging (MRI) in evaluation, treatment in the form of injection, and recurrence rates. Player-specific demographics included age, level of play, position, batting side dominance, and throwing side dominance. All data were deidentified and void of player name and team.

Multiple comparisons were made between level of play (MLB vs MiLB), mechanism (batting vs pitching), injury side (lead side vs trailing side), evaluation (MRI vs no MRI), and treatment rendered (injection vs no injection), to name a few. For injured side comparisons, injuries occurring on the contralateral side of hitting or throwing arm dominance were classified as “lead side injuries,” while those occurring ipsilateral to the hitting or throwing arm dominance were considered “trailing side injuries.” For these comparisons, switch hitters and those with unknown side dominance were excluded. When analyzing time of year, injuries were classified by both season (spring training, regular season, or postseason) and month of the year. For month of the year comparisons, only March through August were analyzed so that off-season months (November, December, January, and February), partial months (February), and final months of the season (September and October) were excluded from analysis. September and October were excluded because athletes injured this close to the end of the year may not have had sufficient time to return to play. Rates of recurrent injuries were analyzed by separating primary injuries from first recurrences, second recurrences, and third recurrences. In order for an injury to be deemed a recurrence, the player had to return to full participation without limitations between injuries. The recurrence rate for primary injuries was calculated by determining what proportion went on to experience at least

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Ethical approval for this study was obtained from the Hospital for Special Surgery Institutional Review Board (study 2015-922).

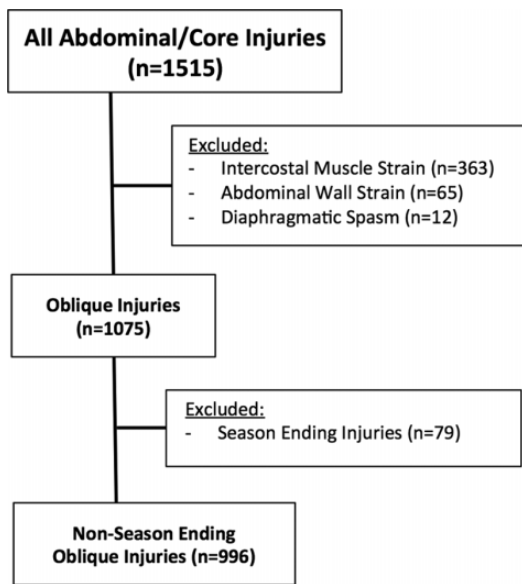


Figure 1. Flowchart demonstrating excluded and included injuries.

1 recurrence. The number, days missed, age, and time since prior injury were analyzed for all recurrences.

Statistical Analysis

All epidemiologic data are reported using descriptive statistics (mean, SD, median, range, frequency, and percentage) where indicated. When making pairwise comparisons between means of continuous variables such as number of DM, a Student *t* test was utilized to assess for significant differences for all normally distributed values, and mean differences (MD) with 95% CIs are provided. When comparing means of 3 or more groups of continuous variables, analysis of variance was performed. For categorical data (eg, pitcher vs hitter, Major vs Minor League, injection vs no injection, lead side vs trailing side), proportions were compared using Fisher exact tests to calculate a 2-tailed *P* value. Differences in the number of observed and expected injuries between groups were compared by chi-square analysis. To determine the significance of trends over time, a best-fit line was generated to illustrate the change over the years. These lines are reported with their corresponding *R*² values. To assess the trend for statistical significance, the slope of this best-fit line was compared with a line with a slope of zero (no change over time) using regression analysis. For all statistical comparisons, the threshold for alpha was set to *P* < .05.

RESULTS

There were a total of 1515 abdominal/core injuries resulting in time out of play (Figure 1) during the study period of 5 seasons. Of these, 1075 oblique injuries were initially included, while intercostal muscle strains (n = 363), abdominal wall strains (n = 65), and diaphragmatic

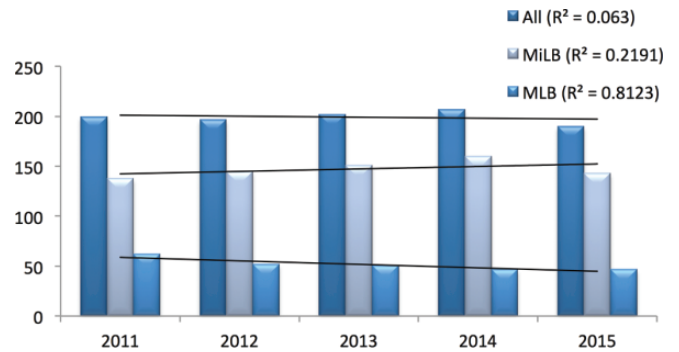


Figure 2. Annual oblique injuries across all levels of professional baseball, Minor League Baseball (MiLB), and Major League Baseball (MLB).

spasms (n = 12) were excluded. After exclusion of the 79 season-ending oblique strains, a total of 996 oblique strains met all inclusion criteria. During the study period, there were 347,609 appearances by MLB players in a total of 24,298 games. This resulted in an injury rate of 1 oblique strain for every 93.8 games played or 1 injury for every 1342 appearances at the MLB level. Calculating injury rates for MiLB is difficult using publically available online Minor League databases because they inconsistently include foreign leagues, winter ball, fall instructional leagues, and independent baseball leagues in their statistical reporting. The number of injuries each season remained steady for all of baseball (*P* = .684) and MiLB (*P* = .427), but the annual incidence decreased for MLB (*P* = .037) (Figure 2). Overall, there were a mean 199.2 injuries per year that ranged from a low of 190 in 2015 to a high of 207 in 2014 (Table 1). A total of 22,064 days were missed during the study period, resulting in a mean 4413 DM per season in all of professional baseball. The fewest number of DM per injury was 19.9 in 2012, while the highest number was 25.3 in 2013. The annual number of DM remained steady at every level (*P* > .05) and ranged from a low of 3927 in 2012 and 2015 to a high of 5114 in 2013 (Figure 3). The mean number of DM per injury was 22.2 (Table 2), which did not change significantly over time (*P* = .671) (Figure 4). The overall reinjury rate was 8.15% (Table 2).

Level of Play: MLB Versus MiLB

These 996 oblique injuries occurred in 259 (26.0%) MLB players and 737 (74.0%) MiLB players who missed a total of 6132 and 15,932 days, respectively (Table 2). MLB players missed a mean 23.7 days while MiLB players missed a mean 21.6 days per injury (MD, 2.1; 95% CI, -0.71 to 4.83; *P* = .144). The mean age at the time of injury for MLB and MiLB players was 29.2 and 24.3 years, respectively (MD, 4.9; 95% CI, 4.44-5.40; *P* < .001). Reinjury rates were similar between the 2 groups (MLB, 10.48%; MiLB, 7.37%; *P* = .162).

Batting Injuries Versus Pitching Injuries

The most common mechanism of injury was batting (n = 455, 45.7%) followed by pitching (n = 348, 34.9%)

TABLE 1
Comparison of Oblique Injuries by Season^a

	All of Baseball		MLB		MiLB		Batting Injuries		Pitching Injuries		Defensive Throwing Injuries	
	n	DM	n	DM	n	DM	n	DM	n	DM	n	DM
2011	200	4647	62	1627	138	3020	79	1946	68	1821	11	161
2012	197	3927	52	1019	145	2908	81	1473	75	1769	13	210
2013	202	5114	51	1343	151	3771	99	2130	75	2296	8	234
2014	207	4449	47	1097	160	3352	102	2240	66	1565	16	276
2015	190	3927	47	1046	143	2881	94	1772	64	1619	10	167
Total	996	22064	259	6132	737	15932	455	9561	348	9070	58	1048
Annual mean	199.2	4412.8	51.8	1226.4	147.4	3186.4	91	1912.2	69.6	1814	11.6	209.6

^aDM, days missed; MiLB, Minor League Baseball; MLB, Major League Baseball.

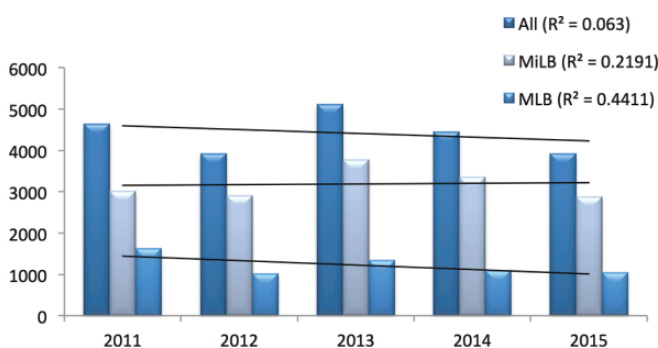


Figure 3. Annual number of days missed across all levels of professional baseball, Minor League Baseball (MiLB), and Major League Baseball (MLB).

(Table 3). Combined, these 2 mechanisms were responsible for 803 (80.6%) oblique injuries and were distantly followed by all remaining mechanisms listed in Table 3. Injuries occurring while batting and pitching resulted in 9561 and 9070 days out of play, respectively, leading to a mean 21.0 DM per batting injury and 26.1 days per pitching injury (MD, 5.1; 95% CI, 2.22-7.88; $P < .001$) (Table 2). The mean number of DM per season for batting and pitching oblique injuries was 1912 and 1814, respectively (MD, 98.2; 95% CI, -288.50 to 484.90; $P = .574$), while the mean age for each group was 26.4 years (range, 18.8-40.3 years) and 25.2 years (range, 18.1-41.2 years), respectively (MD, 1.21; 95% CI, 0.65-1.77; $P < .001$). Recurrence rates between hitting (8.72%) and pitching injuries (6.58%) were similar ($P = .331$). Hitting-side dominance was available for 346 of the 455 injuries that occurred while batting (60 switch hitters and 49 hitters with unknown dominance were excluded). Of these 346 injuries, 250 (72.3%) occurred to the lead side while 96 (27.7%) presented in the trailing side ($P < .001$) (Table 4). For the 394 injuries occurring while throwing, 348 (88.3%) were in pitchers while 46 (11.7%) occurred in fielders (nonpitchers). For the 348 pitching injuries, 287 (82.5%) occurred in the lead side and 61 (17.5%) occurred in the trailing side ($P < .001$). A similar trend was noted for the 46 injuries occurring during defensive throws (nonpitchers), where 35 (76.1%) were in the leading side and 11 (23.9%) were in the trailing side

($P < .017$). Overall, there was an increased number of DM for leading side injuries compared with trailing side injuries ($P = .009$).

When looking specifically at starting pitchers versus relief pitchers, starters represented 5973 days out of play while relievers lost 3097 days. Mean DM per injury were 27.4 for starters and 23.8 for relievers (MD, 3.6; 95% CI, -0.98 to 8.13; $P = .123$). Starting pitchers missed more days per season than relievers (1195 and 619 days, respectively; MD, 575.2; 95% CI, 326.38-824.02; $P < .001$). Relief pitchers were older (26.1 vs 24.6 years) at the time of injury (MD, 1.5; 95% CI, 0.74-2.30; $P < .001$). Reinjury rate for starting pitchers was 4.90%, while that of relief pitchers was 9.57% ($P = .156$) (Table 2).

Timing of Injuries

Regarding timing of these injuries, the majority occurred during the season ($n = 781$, 78.4%) followed by spring training ($n = 196$, 19.7%) and the postseason ($n = 19$, 1.9%). When comparing injuries from month to month, there was a slight trend toward decreased injuries as the season progressed from month to month ($P = .083$) (Figure 5). Of the 897 oblique strains that occurred over the 6-month period from March to August, 491 occurred in the first 3 months of full activity (March to May) while 406 occurred in the last 3 months (June to August) ($P = .005$).

Evaluation and Treatment

MRI was performed for 183 (18.4%) injuries while only 11 (1.1%) underwent ultrasound evaluation. A total of 79 (7.9%) players received either a corticosteroid ($n = 56$, 70.9%) or platelet-rich plasma (PRP) ($n = 23$, 29.1%) injection (Table 5). The mean time between injury and injection was 6.3 days. Players receiving an injection (either corticosteroid or PRP) returned at a mean 32.3 days (range, 1-124 days) compared with 21.3 days (range, 1-160 days) for those without an injection (MD, 11.0; 95% CI, 6.60-15.46; $P < .001$). Those undergoing injection with corticosteroid returned at a mean 29.0 days compared with 40.3 days for the PRP group (MD, 11.4; 95% CI, 1.65-21.08; $P = .022$).

TABLE 2
Summary of Oblique Injuries by Level of Play, Most Common Mechanisms, Pitching Role, and Treatment^a

	n (%)	Total DM	DM per Injury			Mean DM per Season (SD)	Mean Age at Injury (SD), y	Reinjury Rate, %
			Mean (SD)	Median	Range			
All players	996 (100)	22,064	22.2 (19.5)	18	1-160	4413 (451.6)	25.8 (4.1)	8.15
MLB	259 (26.0)	6132	23.7 (21.2)	20	1-154	1226 (230.8)	29.2 (4.1)	10.48
MiLB	737 (74.0)	15,932	21.6 (18.9)	18	1-160	3186 (336.9)	24.3 (3.1)	7.37
Mean difference			2.1				4.9	
95% CI			-0.71 to 4.83				4.44 to 5.40	
P value			.144				<.001	.162
Batting injuries	455 (45.7)	9561	21.0 (19.6)	17	1-139	1912 (271.5)	26.4 (4.2)	8.72
Pitching injuries	348 (34.9)	9070	26.1 (21.0)	23	1-160	1814 (258.6)	25.2 (3.7)	6.58
Mean difference			5.1			98.2	1.2	
95% CI			2.22 to 7.88			-288.50 to 484.90	0.65 to 1.77	
P value			<.001			.574	<.001	.331
Starting pitchers	218 (62.6)	5973	27.4 (23.2)	23	1-160	1195 (213.0)	24.6 (3.4)	4.90
Relief pitchers	130 (37.4)	3097	23.8 (16.4)	21	1-81	619 (113.3)	26.1 (3.8)	9.57
Mean difference			3.6			575.2	1.5	
95% CI			-0.98 to 8.13			326.38 to 824.02	0.74 to 2.30	
P value			.123			<.001	<.001	.156

^aBoldfaced values signify statistical significance ($P < .05$). DM, days missed; MiLB, Minor League Baseball; MLB, Major League Baseball.

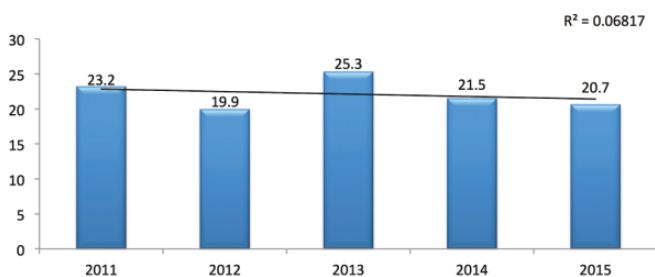


Figure 4. Mean number of days missed per oblique injury.

Recurrence Rates

Of the 907 primary injuries, 74 had at least 1 recurrence at a mean of 428 days after the primary injury (Table 6). Twelve players experienced at least 2 recurrences, and 3 had a third recurrence during the study period. There were a total of 1763 DM for the 89 recurrent injuries yielding a mean 19.8 DM per recurrent injury. There were no differences in the mean age ($P = .161$), DM per injury ($P = .234$), or days since prior injury ($P = .271$) across the primary injury and recurrence groups. Of the 74 first-time recurrences, 37.8% occurred in same season while 61.2% recurred in a subsequent season.

DISCUSSION

Although abdominal oblique injuries are a well-documented cause of disability and time out of play in professional baseball, little is known about the most recent injury trends and characteristics. The purpose of this work was to utilize HITS data to better understand the current incidence of abdominal oblique injuries, their impact on time out of play, and key injury characteristics

that can be used to identify players most at risk. The hypothesis that injury rates would be declining over the past 5 seasons did not hold up for MiLB, but the annual incidence is declining for MLB. Despite this, oblique strains are responsible for over 4400 days (the equivalent of 24 full-length MLB seasons) out of play in all of professional baseball each year. The most common mechanisms for injury are batting and pitching, with pitchers requiring a mean 5.1 days longer to recover from each injury than hitters. The leading side is injured in over 77% of cases, which takes longer to recover from than trailing side injuries by approximately 5 days. Ultimately, 8.15% of players will go on to experience at least 1 injury recurrence a mean 428 days after full return to play.

To date, this study represents the most comprehensive review of oblique injuries in professional sports; however, it is certainly not without its limitations. This work relies on data from the MLB EMR and HITS, which includes injury information on every MLB and MiLB player since the 2011 season, making it the most robust professional sports database of its kind.¹⁴ As with all databases, its utility is dependent up the accuracy and quality of the data entered. Although athletic trainers and medical staff make great effort to enter data in a consistent and reliable fashion, the possibility for data entry discrepancy does exist. Additionally, this work is limited by its narrow scope of treatment information available. Other than injections, additional treatment strategies (rest, oral medications, therapy programs, etc) cannot be analyzed reliably. It is also limited in that season-ending injuries could not reliably be included in the calculation of mean DM. The strengths of this study are its comprehensive nature that spans all levels of professional baseball, clinical relevance given the high incidence of this pathology, inclusion of nearly 1000 injuries, focus on specific player and injury characteristics, and report of numerous novel comparisons and findings.

TABLE 3
Summary of Oblique Injuries Based on Mechanism

Mechanism	n (%)	Rank	Total Days Missed	Days Missed per Injury		
				Mean	Median	Range
Batting	455 (45.7)	1	9561	21.0	17	1-139
Pitching	348 (34.9)	2	9070	26.1	23	1-160
Throwing (nonpitcher)	58 (5.8)	3	1048	18.1	14.5	1-72
Fielding	49 (4.9)	4	920	18.8	16	1-71
Other	35 (3.5)	5	656	18.7	14	1-60
Base running	21 (2.1)	6	390	18.6	16	2-47
Weight lifting/conditioning	14 (1.4)	7	134	9.6	7.5	1-28
Unknown	9 (0.9)	8	163	18.1	19	4-37
Sliding	7 (0.7)	9	122	17.4	16	9-43
Totals	996 (100)		22,064	22.2	18	1-160

TABLE 4
Comparison of Oblique Injuries Based on Body Side^a

	Batters ^b			Pitchers			Defensive Throwers (Nonpitchers) ^c			Overall		
	n (%)	Total DM	DM per Injury	n (%)	Total DM	DM per Injury	n (%)	Total DM	DM per Injury	n (%)	Total DM	DM per Injury
Lead side ^d injuries	250 (72.3)	5666	22.7	287 (82.5)	7692	26.8	35 (76.1)	727	20.8	572 (77.3)	14,085	24.6
Trailing side ^e injuries	96 (27.7)	1854	19.3	61 (17.5)	1378	22.6	11 (23.9)	121	11.0	168 (22.7)	3353	20.0
Total	346	7520	21.7	348	9070	26.1	46	848	18.4	740	17,438	23.6
<i>P</i> value	<.001	<.001	.163	<.001	<.001	.154	.017	<.001	.077	<.001	<.001	.009

^a*P* values were calculated by comparing the lead side and trailing side variables for each column. Boldfaced values signify statistical significance ($P < .05$). DM, days missed.

^bSwitch hitters ($n = 60$) and batters with unlisted side dominance ($n = 49$) were excluded from this analysis.

^cDefensive players with unlisted throwing dominance ($n = 12$) were excluded from this analysis.

^dLead side is defined as the opposite side of hitting or throwing dominance (ie, left side for right-handed thrower/hitter).

^eTrailing side is defined as the same side as hitting or throwing dominance (ie, right side for right-handed thrower/hitter).

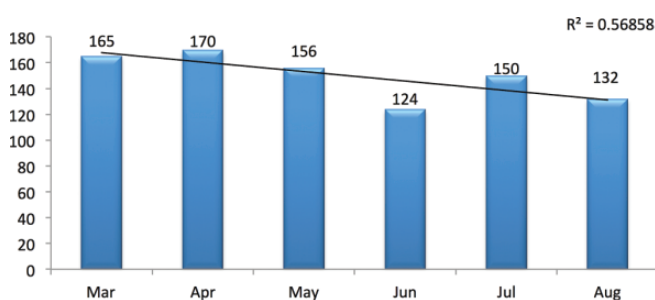


Figure 5. Number of oblique injuries by month of the year ($P = .083$). Significantly more injuries occurred in the first 3 months (March-May) compared with the last 3 months (June-August) of the season (491 vs 405; $P = .005$).

After publication of the first report of abdominal strains in MLB in 2012,³ increased attention was paid to this common cause of injury by professional baseball players, medical staff, front offices, and the media.^{2,3,11,18} The increasing injury rates noted over the 1991 to 2010 seasons not only raised awareness but produced a fair amount of concern

that stigmatized the diagnosis because players missed an average of 27 (position players) or 35 (pitchers) days per injury and experienced a 12% reinjury rate.^{12,16} Although we cannot say for certain, our experience in professional baseball suggests that this stigma may have led a number of medical providers to lean toward diagnosing some of these injuries as “intercostal strains” rather than the more negatively connoted “oblique strain.” This could be one possible explanation for the surprisingly large number of intercostal strains ($n = 363$) that were observed during the 2011 to 2015 seasons. Although many of these may have actually represented oblique injuries, they were excluded from this analysis to reduce confounding potential. One of the more positive outcomes of this heightened awareness of oblique strains was the increased attention paid to preemptive core strengthening and injury prevention programs in professional baseball.^{4,18} This may very well have contributed to the reduced injury incidence noted in MLB since 2011.

Despite the decline in injuries in MLB, the annual incidence remains steady in MiLB, and these injuries are still responsible for a significant amount of time out of play. The decline at the MLB level may be a result of increased attention and concern for injury prevention at this level

TABLE 5
Summary of Time Out of Play Based on Injection Status^a

	n (%)	Mean (SD) Days Between Injury and Injection	Days Missed per Injury			Mean Difference	95% CI	P Value
			Mean (SD)	Median	Range			
No injection	917 (92.1)	—	21.3 (19.2)	17	1-160	11.0	6.60 to 15.46	<.001
Any injection	79 (7.9)	6.3 (7.0)	32.3 (20.3)	28	1-124			
Corticosteroid injection	56 (70.9)	6.5 (7.5)	29.0 (18.1)	27	1-72	11.4	1.65 to 21.08	.022
PRP injection	23 (29.1)	5.8 (5.7)	40.3 (23.3)	32	15-124			

^aBoldfaced values signify statistical significance ($P < .05$). PRP, platelet-rich plasma.

TABLE 6
Summary of Recurrent Oblique Injuries^a

	n (%)	Total DM	Mean Age (SD), y	DM per Injury			Days Since Prior Injury		
				Mean (SD)	Median	Range	Mean (SD)	Median	Range
Primary injury	907 (91.0)	20,301	25.7 (4.1)	22.4 (19.4)	19	1-160			
First recurrence	74 (7.4)	1582	26.5 (3.5)	21.4 (21.3)	15.5	1-139	428 (397.3)	324	1-1383
Second recurrence	12 (0.1)	145	27.5 (3.8)	12.1 (11.9)	7.5	1-36	420 (370.1)	334	99-1492
Third recurrence	3 (0.0)	36	27.1 (1.5)	12 (5.9)	10	6-20	55 (25.1)	51	27-88
Totals	996	22,064	25.8 (4.1)	22.2 (19.5)	18	1-160	415 (392.7)	311	1-1492
P value ^b			.161	.234			.271		

^aDM, days missed.

^bAnalysis of variance.

compared with MiLB, but this has not been formally studied. Currently, MLB players lose a total of 1226 days per season while MiLB players are missing 3186 days each year. The performance, competition, and financial impacts of this lost time remain substantial. While the overall mean time out of play was 22.2 days per injury, batters injured during a swing miss a mean 21.0 days, and pitchers injured on the mound miss an even greater amount of time (26.1 days) per injury. This is likely due to the extreme force transmitted through the trunk during these high-demand rotational movements. When swinging a bat, the trunk reaches a mean maximal angular acceleration of $7200 \pm 2800 \text{ deg/s}^2$ just after contact, and the angular acceleration of pitchers is even greater at $11,600 \pm 3100 \text{ deg/s}^2$ as the front foot lands on the ground.⁷ Given these extraordinary speeds during pitching and batting, it is not surprising that these represent common injury mechanisms.

Similar to the prior work of Conte et al,³ the leading side oblique was injured in 72% of batters, 83% of pitchers, and 76% of defensive throwers who were injured. The leading side was responsible for more injuries (77.2% overall; $P < .001$), more total DM (14,085 vs 3353; $P < .001$), and greater DM per injury (24.6 vs 20.0; $P = .009$) than trailing side injuries (see Table 4). Also, similar to prior research, significantly more injuries occur in the first 3 full months of baseball activity (491 injuries) compared with the last 3 months of full activity (406 injuries; $P = .005$). Because so many injuries occur early in the season and over 75% manifest on the lead side, these specific injury patterns may represent appropriate targets for prevention and strengthening programs. This may be especially true for

pitchers who demonstrate increased DM per injury compared with batters.

Regarding treatment, injuries that received an injection demonstrated increased time out of play. In the only other known report on this topic, Stevens et al¹⁹ reported on 3 MLB pitchers who received ultrasound-guided injection to treat oblique strains. They found that the mean time to return to full status was 30.7 days, which is similar to the findings of the current study. Although the precise cause of this cannot be determined from this study, a few potential explanations exist. It is possible that more severe injuries tended to be the ones injected or that medical staff may have reduced the pace of rehabilitation for a period after injection; however, it is also possible that the injection may have negatively affected the healing response in some fashion. It is worth noting that the mean time from injection to injury was 6.3 days but the mean time to return to play was 11 days greater than those not injected. Based on these results, injection of oblique injuries should be approached with a certain level of caution, and injection should not be performed universally.

CONCLUSION

With 996 injuries leading to time out of play in the past 5 seasons, abdominal oblique injuries continue to represent a significant source of missed days from professional baseball. Although the annual incidence remains steady in MiLB, oblique injuries appear to be on the decline in MLB. This may be due in part to the recent increased focus on preemptive core and trunk strengthening. Oblique strains

occurring while pitching or batting represent the vast majority (81%) of all injuries. Ultimately, players miss an average of 22.2 days per injury, with pitching (26.1 DM) and lead side (24.6 DM) injuries resulting in the greatest amount of time out of play. Pitchers miss a mean 5 days more than position players for each injury, and players who received an injection missed 11 days more than those who did not. Although the recurrence rate is fairly low at 8.15%, some players may go on to experience 2 or 3 additional recurrences after returning to full activity.

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