Outcomes of Cervical and Lumbar Disk Herniations in Major League Baseball Pitchers

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Abstract: The effects of disk herniations on the career and performance outcomes of Major League Baseball (MLB) pitchers are unknown. The purpose of this study is to determine the outcomes after a cervical or lumbar disk herniation for MLB pitchers. Forty MLB pitchers from 1984 to 2009 with a cervical disk herniation or lumbar disk herniation were identified using a previously established protocol. Cervical disk herniation was identified in 11 pitchers, 8 of which were treated operatively. The majority of pitchers with cervical disk herniation (8/11) returned to play at an average of 11.6 months. Lumbar disk herniation was identified in 29 pitchers, 20 of which were treated operatively. All pitchers with lumbar disk herniation (29/29) returned to play at an average of 7.3 months after diagnosis.

Compared to other Major League Baseball (MLB) players, pitchers are disproportionately represented on the disabled list, accounting for 57% of disabled list days. A significant number of these injuries involve the spine, and prevalent among these are lumbar and cervical disk herniations. A study of college athletes found baseball players to be at the highest risk of lumbar disk degeneration compared to other groups of athletes, at a rate >3 times that of nonathlete controls. Baseball players are known to develop lumbar disk herniations, comprising 13% to 35% of reported cases in studies of elite athletes. However, the effects of lumbar disk herniation treatment on performance after treatment are unknown. Although cervical disk herniations have also been diagnosed in professional athletes, no data exist that can guide expectations after treatment, especially for pitchers.

The outcomes for pitchers with disk herniations in the cervical or lumbar spine merit specific consideration, as the pitching motion is one of the most demanding high-speed torsional activities in sports. Studies with dynamic electromyography have shown that professional pitchers generate high torsional forces across the trunk and spine that are known to produce annular tears and disk herniations. Returning to the normal function of pitching after a disk herniation therefore represents a distinct challenge relative even to other elite level athletic endeavors. Despite published reports suggesting a favorable prognosis of disk herniations in among elite athletes, there remains a common public misconception that these injuries may signal the end of a player’s career, especially if treated with surgery.

Because existing studies of disk herniations in elite athletes have only reported outcomes collectively, further study is required to aid the decision-making process for unique positions such as that of the elite-level pitcher. The purpose of this study is to investigate the outcomes after treatment of cervical and lumbar disk herniation in professional MLB pitchers.

Materials and Methods

Inclusion and Exclusion Criteria

Using a previously established protocol, a clinical database of MLB players with the diagnosis of cervical or lumbar disk herniation was compiled through newspaper archives, team injury reports, player profiles, and press releases. All data sources were obtained from the public record. Inclusion criteria were athletes with primary position as a pitcher, reported “disk herniation” or “herniated disk” in the cervical or lumbar spine, active status on an MLB team at the...
time of injury, and a treatment plan confirmed from at least 2 different sources. Surgical treatment of cervical disk herniation was defined as either a 1-level anterior cervical diskectomy and fusion or cervical disk replacement. For lumbar disk herniation, only players who underwent a lumbar discectomy with or without laminotomy were included for data analysis. Players with indeterminate or conflicting medical information, diagnoses of cervical or lumbar “strain” or “degenerated disk,” and who are not pitchers were excluded.

Outcome Measures
For each player, demographic information such as age, MLB debut date, height, weight, and position was recorded from public MLB data sources. Body mass index (BMI) was calculated as weight (kg) divided by the square of height (m). The date of injury, type of treatment, and date of surgery (if applicable) were recorded and confirmed from at least 2 independent published sources. Data for the last game played and date of return-to-play (if applicable) were recorded from aforementioned sources.

Successful return-to-play was defined as being on the active roster of an MLB team for at least 1 season after treatment. Time to return-to-play was calculated as the length of time between the last game played before injury and the first game played after treatment at the MLB level (minor league games were excluded). Major League Baseball experience at time of injury was calculated as the time between the MLB debut date and date of injury, and the number of games played prior to injury. The number of games played after injury was recorded, up to the end of the 2009 season for current players.

Performance-based outcomes were compiled from game statistics from public MLB data sources for earned run average, innings pitched, and walks plus hits per innings pitched for all seasons before injury, and all seasons after return-to-play. Earned run average is defined as the average number of earned runs allowed by a pitcher per 9 innings pitched; a lower number indicates better performance. Walks plus hits per innings pitched is defined as the average number of allowed walks plus hits per innings pitched; a lower number indicates better performance. These pitching statistics have been previously reported in the literature to assess performance after orthopedic procedures in MLB pitchers.21 If data for a complete season were unavailable prior to injury (eg, if a player was injured in his rookie year), the player was excluded from pre- and post-injury performance comparison. Comparisons were made between per-season averages for each pitcher’s career pre- and post-treatment. Data from incomplete seasons (eg, if a player was injured mid-season or returned to play mid-season) were excluded to avoid measurement bias in calculating per-season averages.

Categorical data was analyzed with Fisher’s exact test. Continuous variables for each cohort were analyzed with a 2-tailed Student t test for normally distributed data. Statistical significance was accepted as P<.05. A multivariate linear regression analysis was performed to control for independent variables such as age at diagnosis, BMI, and MLB experience.

RESULTS
Forty MLB pitchers diagnosed with cervical disk herniation and lumbar disk herniation from 1984 to 2009 met the inclusion criteria. Eleven pitchers were identified with cervical disk herniation, and 29 pitchers with lumbar disk herniation. Demographic data including age, BMI, and MLB experience was similar for pitchers with cervical disk herniation and lumbar disk herniation (P>.05) (Table 1). A similar percentage of pitchers with cervical disk herniation (73%) and lumbar disk herniation (69%) were treated surgically (P=1.00). In the cervical disk herniation cohort, 7 pitchers underwent anterior cervical discectomy and fusion and 1 pitcher underwent cervical disk replacement. Those with lumbar disk herniation all underwent microdiscectomy and/or laminotomy (Table 2).
Return-to-Play and Career Length

The majority of pitchers with cervical disk herniation successfully returned to play (8/11; 73%) at an average time of 11.6 months after diagnosis. Pitchers with cervical disk herniation treated with surgery returned to play at a higher rate (7/8; 88%) than those treated without surgery (1/3; 33%), but the difference was not statistically significant with the numbers available (P=.15) (Table 3). Average career length prior to treatment for cervical disk herniation was 160 games over 5.1 years, and average career length after treatment was 63 games over 3.7 years (Figure 1). Subgroup analysis by treatment type showed no significant differences in age or post-treatment career length (Table 4).

All pitchers with lumbar disk herniation successfully returned to play after treatment (29/29; 100%). The average time to return-to-play for pitchers with lumbar disk herniation was 7.3 months. Subgroup comparison based on type of treatment showed no difference in time to return-to-play rates (Table 3). For pitchers with lumbar disk herniation, career length prior to treatment was 282 games over a 7.5-year period, and average career length after treatment was 121 games over 5.1 years (Figure 2). Subgroup analysis for pitchers with lumbar disk herniation showed that those who underwent surgery were older and more experienced compared to those who had nonoperative treatment (P<.03) (Table 4). However, there was no significant difference in post-treatment career length for pitchers with lumbar disk herniation treated with or without surgery (Table 4).

Performance-based Outcomes

Pitchers with cervical disk herniation had significantly fewer average innings pitched per season after treatment (41.7±43.1) compared to before treatment (68.5±44.7) (P=.04). With the limited numbers available, there were no significant differences in per-season averages for earned run average before and after treatment or walks plus hits per innings pitched (Tables 5, 6; Figure 3). For those treated operatively, no significant differences were noted in performance-based outcomes pre- and postoperately. Statistical comparisons were not possible for the nonoperative group due to limited numbers available (Table 6).

Pitchers with lumbar disk herniation demonstrated significantly fewer innings pitched per season after treatment (92.5±61.1) compared to before treatment (116.3±66.9) (P=.03). However, there was no significant difference in per-season earned run average after treatment (5.34±4.38) compared to before treatment (3.85±0.85) (P=.08), or walks plus hits per innings pitched before and after treatment (1.35±0.18 vs 1.47±0.37) (P=.11) (Table 7; Figure 4).

Pitchers with lumbar disk herniation treated surgically demonstrated significantly fewer innings pitched per season (89.3±54.6 vs 121.4±66.2; P=.02) and significantly increased walks plus hits per innings pitched (1.52±0.38 vs 1.31±0.15; P=.02) after treatment compared to before treatment. There was no significant difference in earned run average after treatment (5.83±5.05) compared to before treatment (3.84±0.69) (P=.10). However, for pitchers treated nonoperatively, there were no significant differences in per-season earned run average, innings pitched, or walks plus hits per season.
The clinical outcomes after treatment for disk herniation of the cervical and lumbar spine in the general population are favorable. However, elite athletes have different concerns from the lay public regarding post-treatment outcomes. Success rates derived from traditional clinical questionnaires such as the visual analog scale, Oswestry Disability Index, and Neck Disability Index may not apply to professional athletes, who are primarily concerned with return-to-play and maintenance of high-level athletic performance.

Furthermore, given the repetitive high stress torsional demands of pitching, successful return to baseline function for elite pitchers would seem more difficult than the general population. It is not surprising that there is a perception among media reporters, MLB players, and team managers that the longevity and performance of a pitcher who has undergone surgery of the spine may be compromised. Misconceptions about these injuries may put players and treating physicians in a challenging situation when faced with decisions regarding treatment.

Data from this study suggest that successful treatment of cervical disk herniation and lumbar disk herniation in MLB pitchers leads to higher return-to-play rates, longer careers, and better performance-based outcomes than we expected. The majority of pitchers with cervical disk herniation (73%) returned to play at an average of 11.6 months after diagnosis and subsequently had substantial careers, pitching in 63 games over 3.7 years. Performance statistics for those returning to play were similar to baseline, regardless of the type of treatment, except that those returning pitched fewer innings per season, which suggests that cervical disk herniation in MLB pitchers has a favorable prognosis, even if treated surgically. To our knowledge, this is the first report of a professional athlete who underwent a cervical total disk arthroplasty and successfully returned to play. These data are favorable compared to a similar study of cervical disk herniation in National Football League (NFL) athletes, in which 60% of those with cervical disk herniation returned to play for an average of 2.2 years, and to reported return-to-work rates for anterior cervical disectomy and fusion and cervical disk replacement in a worker’s com-
All pitchers with lumbar disk herniation (100%) returned to play at an average of 7.3 months after diagnosis, for an average of 121 games over 5.1 years. For the entire lumbar disk herniation cohort, regardless of treatment, those players returning to play pitched fewer innings per season, but also had similar statistical performance before and after treatment. However, for the operative group, performance as

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Abbreviations: ERA, earned run average; IP, innings pitched; SD, standard deviation; tx, treatment; WHIP, walks plus hits per innings pitched.

*Paired 2-tailed Student t test.
measured by walks plus hits per innings pitched significantly worsened after return-to-play, although earned run average was not different than baseline. The reasons for this finding are unclear. Because potential confounders such as age and MLB experience can affect performance, the difference in age between groups was likely a contributing factor. Furthermore, disease severity or associated neurologic deficits, both of which were not controlled for in this study, could have affected the results. Finally, because of the inherent limitations of the methodology of this study, with the numbers available, this finding could have been a result of mere chance. These data are favorable compared to a similar study of lumbar disk herniation in NFL linemen, in which 70% of those with lumbar disk herniation returned to play for an average of 2.2 years, and to reported return-to-work rates for laborers (53%) and data from the Spine Patient Outcomes Research Trial (76%).

Further study is required to assess the impact of repetitive torque-producing actions on the long-term health of the lumbar spine. While some authors have stated that sports with repetitive throwing motions leads to increased incidence of degenerative disk disease, this has not been proven in a controlled trial. It remains a possibility that the morbidity of surgical treatment may somehow impair the ability of the lumbar spine to handle the repetitive torsional demands of pitching, but a prospective trial would be required to support this claim.

The literature reporting the clinical outcomes of spinal disorders in elite athletes is limited, and even more so when considering outcomes specific to a particular position such as pitching. Return-to-play has been shown to be >90% after single-level microdiscectomy in 14 elite college athletes, but the cohort did not include baseball players. Mochida et al studied 30 elite athletes undergoing percutaneous nucleotomy for lumbar disk herniation and showed worse outcomes in athletes compared to nonathlete controls, with a success rate of only 57% at 2-year follow-up. However, the study included only 4 baseball players, and the positions of the players were not indicated. Watkins et al reported 60 Olympic and professional athletes who underwent lumbar microdiscectomy, with 88% returning to their chosen sport in an average of 5.2 months postoperatively. In this cohort, 19 of the 21 athletes who were baseball players returned to sport (90.5%) at a mean time of 5.3 months, although the positions of the players were not indicated. Currently only 1 study in the literature addresses cervical disk herniation in elite athletes, as most of the existing literature on cervical spine injuries in athletes focuses on catastrophic injuries such as spinal cord injury. Of note, in our study, none of the pitchers with cervical disk herniation suffered a spinal cord injury after returning to play, regardless of the method of treatment. There are recognizable limitations to this study. First, diagnosis information and type of treatment were obtained from the public record, which creates a possibility of reporting errors, inaccurate classification of diagnosis, and selection bias. Because clinical or radiographic data was not available, it is impossible to determine the individual characteristics of each cervical disk herniation or lumbar disk herniation that may affect outcome. Finally, confounding variables, such as a typical performance decline over the course of a player’s career, concomitant unrelated injuries, or external factors such as management decisions affecting assignments, may also have affected data in this study.

Despite these limitations, at the present time, more detailed data for these types of injuries in this specific population are not available in the literature, and, furthermore, current professional league injury reports do not account for these outcome measures. Thus, this study design represents the best available method to address these important questions. We believe that accurate reporting of injuries and clinical outcomes in professional league injury databases would improve the ability of treating physicians to more accurately counsel specialized players with these types of injuries.

CONCLUSION

The data in this study suggest that treatment for cervical disk herniation or lumbar disk herniation in MLB pitchers can lead to high rates of return-to-play and stable elite-level performance after treatment. Both cervical disk herniation and lumbar disk herniation can be treated surgically, with favor-
able prognosis for return-to-play, career longevity, and performance-based outcomes.

References