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Joseph S. Tramer

Henry Ford Health, jtramer1@hfhs.org

Lafi S. Khalil

Henry Ford Health, lkhalil2@hfhs.org

Patrick Buckley

Henry Ford Health, pbuckle3@hfhs.org

Alexander Ziedas

Henry Ford Health, aziedas2@hfhs.org

Patricia A. Kolowich

Henry Ford Health, Pkolowi1@hfhs.org

See next page for additional authors

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Authors

Joseph S. Tramer, Lafi S. Khalil, Patrick Buckley, Alexander Ziedas, Patricia A. Kolowich, and Kelechi R. Okoroa

Effect of Achilles Tendon Rupture on Player Performance and Longevity in Women's National Basketball Association Players

Joseph S. Tramer,^{*†} MD, Lafi S. Khalil,[†] MD, Patrick Buckley,[‡] BS, Alexander Ziedas,[‡] BS, Patricia A. Kolowich,[†] MD, and Kelechi R. Okoroha,[†] MD

Investigation performed at Henry Ford Health System, Detroit, Michigan, USA

Background: Women's National Basketball Association (WNBA) players have a greater incidence of lower extremity injury compared with male players, yet no data exist on functional outcomes after Achilles tendon rupture (ATR).

Purpose: To evaluate the effect of Achilles tendon repair on game utilization, player performance, and career longevity in WNBA athletes.

Study Design: Cohort study; Level of evidence, 3.

Methods: WNBA players from 1997 to 2019 with a history of ATR ($n = 12$) were matched 1:2 to a healthy control group. Player characteristics, game utilization, and in-game performance data were collected for each athlete, from which the player efficiency rating (PER) was calculated. Statistical analysis was performed comparing postinjury data to preinjury baseline as well as cumulative career data. Changes at each time point relative to the preinjury baseline were also compared between groups.

Results: Of the 12 players with ATR, 10 (83.3%) returned to play at the WNBA level at a mean (\pm SD) of 12.5 ± 3.3 months. Four players participated in only 1 WNBA season after injury. There were no differences in characteristics between the 10 players who returned to play after injury and the control group. After return to play, the WNBA players demonstrated a significant decrease in game utilization compared with preinjury, playing in 6.0 ± 6.9 fewer games, starting in 12.7 ± 15.4 fewer games, and playing 10.2 ± 9.1 fewer minutes per game ($P < .05$ for all). After the index date of injury, the players with Achilles repair played 2.1 ± 1.2 more years in the WNBA, while control players played 5.35 ± 3.2 years ($P < .01$). Additionally, the players with Achilles repair had a significant decrease in PER in the year after injury compared with preinjury (7.1 ± 5.3 vs 11.0 ± 4.4 ; $P = .02$). The reduction in game utilization and decrease in PER in these players was maintained when compared with the matched controls ($P < .05$ for both).

Conclusion: The majority of WNBA players who sustained ATR were able to return to sport after their injury; however, their career longevity was shorter than that of healthy controls. There was a significant decrease in game utilization and performance in the year after return to play compared with healthy controls.

Keywords: basketball; WNBA; Achilles rupture; performance; female

Achilles tendon rupture (ATR) occurs with an incidence between 8.3 and 24 per 100,000 in the United States annually,^{17-19,27,31} affecting predominantly middle-aged men.^{8,31} A large registry study over a 10-year period noted that only 21% of ATR occurred in women and showed the incidence of rupture increasing over time in both sexes.¹¹ In the United States, ATRs are most commonly related to sporting injuries, predominantly basketball.^{17,19,27} In professional athletes, these injuries may signify the end of a career, with some studies estimating that approximately 30% to 39% of athletes do not return to play (RTP) to a professional level after surgical Achilles tendon repair.^{1,18,33} Sports such as

basketball that rely on quick bursts of acceleration, short intervals of changing direction, and repeated jumping for shots and rebounds are likely to increase the repetitive demand on the Achilles tendon.^{16,30} Professional male basketball players have historically performed worse upon returning from Achilles repair as compared with returning from other orthopaedic surgical procedures.^{22,33}

In a retrospective comparison of injuries between male and female professional basketball players, Women's National Basketball Association (WNBA) athletes were found to sustain a higher rate of lower extremity injuries (14.6 vs 11.6) per 1000 athlete-exposures ($P < .05$).⁶ In an epidemiological study of 506 athletes who participated in the WNBA Combine from 2000 to 2008, ankle sprains were the most commonly reported injury (47.8%).²¹ Although tripeps surae strain and Achilles tendon inflammation were

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described, neither study commented on ATRs. The prognosis and career outlook after Achilles repair are important considerations for athletes, coaches, and organizations. As players navigate future contracts and career endeavors, the orthopaedic surgeon's role in managing these injuries is to provide athletes the greatest opportunity to not only RTP, but also be able to contribute to their teams in a manner consistent with their baseline.²⁸ In National Basketball Association (NBA) athletes who return to sport after Achilles repair, performance reductions relative to baseline were greater than those seen in controls for the first 2 seasons after RTP.¹ Similar outcomes have been demonstrated across professional football, hockey, and baseball players.³³

There is a paucity in the literature regarding the outcomes in WNBA players after Achilles tendon repair. As the WNBA continues to expand and gain popularity, the career implications after these injuries will require continued investigation. The purpose of this study was to evaluate the effect of ATRs on game utilization, player performance, and career longevity in WNBA athletes. We hypothesized that after Achilles repair, WNBA athletes will experience reduced game utilization and performance relative to their preinjury baseline and compared with healthy controls. Additionally, we expected reduced career longevity in WNBA athletes after Achilles tendon repair.

METHODS

We performed a retrospective review of ATRs sustained by all WNBA players from 1997 to 2019. Players were initially identified using online sources available to the public, including pages dedicated to profiles of athletes, news reports, fan-based websites, statistics-based websites, and general web searches, consistent with similar investigations.^{9,12-14,20,26,32} All players were then identified on a statistics-based website in order to confirm gaps in playing time, and a list of players was compiled to ensure that each athlete was only represented once. All WNBA players with a history of Achilles injury were included. Exclusion criteria consisted of injuries preceding their professional career and a history of other lower extremity surgeries. A search was also performed on each player to determine if failure to return to the WNBA was due to playing in an overseas basketball league. Two authors (J.S.T., L.S.K.) independently verified all reported injuries and cross-referenced the timeline with missing in-game statistics to validate the sources.

The index year corresponded to the season of injury for players with an Achilles rupture. A 2:1 group of healthy controls in the WNBA were matched by age, years of experience, position played, height, and body mass index. Control players were excluded if there were any documented lower extremity surgeries during their WNBA career. Each control player was matched to a player with an Achilles rupture, such that the index year for the control player matched the age and seasons of experience at the time of the injury. Data collection followed for 3 seasons before the index year (years -1, -2, and -3) and for 3 years after RTP (years 1, 2, and 3). However, only 6 and 2 players remained active in the WNBA during the second and third seasons after Achilles tendon repair, respectively; therefore, direct comparisons could only be made for the year before and after injury.

Player characteristics, game utilization, and game performance data were documented for all Achilles rupture and control players. RTP was determined by the first WNBA game played after Achilles tendon repair. Game utilization metrics included seasons played, games per season, games started, and minutes per game (MPG). Performance data collected included points, rebounds, assists, steals, blocks, field goals made, field goal percentage, free throws made, free throw percentage, and turnovers. The player efficiency rating (PER) is a standardized performance measure utilized for professional athletes and is a powerful tool for statistical comparison of performance in the literature.^{1,4,23,24,33} We calculated the PER for WNBA athletes in the present cohort using the same formula: the sum of [*points + rebounds + assists + steals + blocks - field goals missed - free throws missed - turnovers*] averaged per number of games played.

Utilization and performance variables were compared between Achilles repair and healthy control groups. Comparisons before and after the index year were executed for data acutely in the first year after RTP compared with the first year before the index season.

Statistical Analysis

All continuous data are reported as mean \pm SD, while categorical data are reported as counts and column percentages. For continuous variables, univariate 2-group comparisons were performed using independent 2-sample *t* tests if the variable was normally distributed and Wilcoxon rank-sum tests if the variable was nonnormally distributed. For categorical variables, univariate 2-group comparisons were performed using chi-square tests when

*Address correspondence to Joseph S. Tramer, MD, Department of Orthopaedic Surgery, Henry Ford Hospital, 2799 W Grand Blvd, Detroit, MI 48202, USA (email: joe.tramer@gmail.com).

¹Department of Orthopaedic Surgery, Henry Ford Hospital, Detroit, Michigan, USA.

[†]Wayne State University School of Medicine, Detroit, Michigan, USA.

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Ethical approval was not sought for the present study.

expected cell counts were >5 and Fisher exact tests when expected cell counts were <5. Comparisons between pre- and postinjury data were performed using paired *t* tests if the variable was normally distributed and Wilcoxon signed-rank tests if the variable was nonnormally distributed. Pearson correlation coefficient tests were used to determine the association of time to return to sport with player characteristics.

For analyzing variables over time, a repeated-measures analysis was performed and included effects for time, group, and time × group. Significant findings for the repeated measures were then analyzed post hoc using pairwise comparisons. A Tukey-Kramer *P* value correction was used to adjust for multiple comparisons. Statistical significance was set at *P* < .05. All analyses were performed using SAS 9.4 (SAS Institute Inc).

RESULTS

Player Characteristics and Return to Play

A total of 12 WNBA players were identified as having an Achilles tendon tear during their basketball career. All tears were treated with Achilles tendon repair; information on time from injury to repair was not readily available. Of these 12 athletes, 10 (83.3%) were able to successfully RTP in the WNBA, with a mean RTP of 12.5 ± 3.3 months after injury. In the 10 athletes who returned to play, 4 played only 2 WNBA seasons after RTP, 2 played in 3 WNBA seasons after RTP, and 2 played in the first 2 seasons after RTP but had not begun their third season. Three of the 12 athletes had documented professional basketball appearances in overseas leagues (Figure 1). After the index date of injury, players in the Achilles repair group played a mean of 2.1 ± 1.2 years in the WNBA, while control players played 5.35 ± 3.2 years (*P* < .01). There were no player characteristics, game utilization, or performance differences before the index season between the Achilles repair players and the matched control players (Table 1).

Game Utilization

In the first year after Achilles tendon repair, the WNBA players played in 6.0 ± 6.9 fewer games (*P* = .02), started 12.7 ± 15.4 fewer games (*P* = .03), and played 10.2 ± 9.1 fewer MPG (*P* < .01) than the year before their injury. Compared with the healthy, matched controls, WNBA players who returned after ATR demonstrated significantly greater reductions in games played (*P* = .05) and MPG (*P* = .05) (Figure 2).

Player Performance

In the season after RTP, the players in the Achilles repair group had a significant reduction in PER, from 11.0 ± 4.4 preoperatively to 7.1 ± 5.3 after surgery (*P* < .02). Direct comparison between the Achilles repair group and control group in the first postindex year did not demonstrate differences in PER; however, the reduction in PER after injury

Player	Injury +1	Injury +2	Injury +3
Player 1	Red	Red	Red
Player 2	Red	Red	Red
Player 3	Red	Green	Blue
Player 4	Green	Red	Red
Player 5	Green	Red	Red
Player 6	Green	Blue	Blue
Player 7	Green	Green	Blue
Player 8	Green	Green	Red
Player 9	Green	Green	Yellow
Player 10	Green	Green	Yellow
Player 11	Green	Green	Green
Player 12	Green	Green	Green

Figure 1. Schematic depicting return to play in the first 3 years after injury. Red = no documented Women’s National Basketball Association (WNBA) games; green = documented WNBA game; blue = documented game overseas; yellow = year outside study period (2020).

TABLE 1
Preinjury Player Characteristic, Game Utilization, and Performance Data Between the Study Groups^a

Variable	Achilles (n = 10)	Control (n = 20)	<i>P</i> Value
Age, y	28.0 ± 4.8	28.8 ± 5.1	.68
Body mass index	22.4 ± 1.5	22.7 ± 1.5	.67
Total games played	170.0 ± 138.4	164.8 ± 120.8	.83
Total games started	123.800 ± 135.6	124.0 ± 129.0	.84
Minutes per game	24.2 ± 6.5	24.2 ± 5.7	.98
Player efficiency rating	11.0 ± 4.4	10.0 ± 4.2	.52

^aData are presented as mean ± SD.

in the Achilles group significantly exceeded the reduction in the control group (Table 2).

DISCUSSION

Our investigation found that 10 of 12 (83.3%) WNBA athletes successfully returned to play after Achilles tendon repair. However, players returning from injury had a relatively short postinjury career after return. Additionally, a significant decrease in game utilization and PER was found compared with preinjury baseline, as well as with a healthy control group.

Injury to the Achilles tendon has the potential to be career ending. As ATR occurs most commonly in middle-aged recreational athletes, the return-to-sport rate in this group has been extensively researched, with a meta-analysis reporting a rate of return to any sport of 80%.³⁵

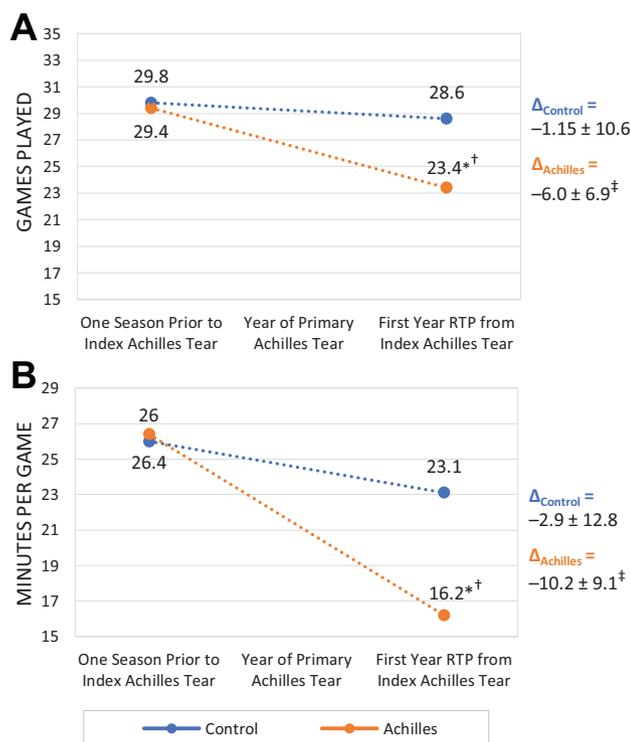


Figure 2. Game utilization trends in (A) games played and (B) minutes per game comparing the season after return to play (RTP) with the season before the index/injury season in Women’s National Basketball Association players. The players with Achilles repair significantly decreased their game utilization after RTP relative to the year before injury, while controls maintained their same workload. Controls demonstrated greater utilization than players with Achilles repair in the year after RTP. The overall reduction in game utilization (Δ) was significantly greater in players with Achilles repair than controls. *Significant difference between groups at a single time point. †Significant difference between 2 time points within a single group. ‡Significant difference between groups for the amount of change in game utilization over time.

TABLE 2
Comparison of PER Before and After Surgery
Between the Study Groups^a

PER	Achilles	Control	P Value
1 year preoperatively	11.0 ± 4.4	10.0 ± 4.2	.52
1 year postoperatively	7.1 ± 5.3	9.9 ± 3.7	.08
Difference	-3.9 ± 4.2	-0.1 ± 4.5	.04

^aData are presented as mean ± SD. The boldface P value indicates a statistically significant difference between groups (P < .05). PER, player efficiency rating.

Focusing on high-level athletes, Trofa et al³³ reviewed all reported ATR in the 4 major male professional athletic leagues and found that only 69.4% of athletes were able to return to the same level of sport after surgical repair of the tendon, with 68.0% of NBA athletes successfully

returning. In a review of ATRs occurring over a 23-year period in the NBA, the reported RTP rate was 11 of 18 (61.1%) players, with 3 of those athletes returning for only 1 season after injury.¹ Similarly, in a study of 44 ATRs occurring in the NBA, Lemme et al¹⁸ reported that 79.5% were able to return after operative repair of their tear. The current study also found a high RTP rate (83%) after Achilles tendon repairs in WNBA athletes. The mean RTP time of 12.5 months was slightly longer when compared with male cohorts or other sports. These results suggest that WNBA players may require additional time to return from Achilles tendon repair compared with their male counterparts. Additionally, the WNBA season is much shorter than the NBA season, which limits the available time span the players have to RTP.

A similar investigation on performance and game utilization by Amin and colleagues¹ evaluated 11 NBA players who returned to play after ATR, in whom they noted a significant decrease in MPG for 2 years after injury as well as a drop in PER compared with healthy controls in the first year after RTP, which however was no longer statistically significant at 2 years. Similar decreases in PER were reported by Lemme et al,¹⁸ who found that individual players had a worse PER of 2.9 points in the year after injury compared with prior, comparable with the 3.9-point drop in PER in the present cohort. Additionally, those authors noted lower game utilization, with fewer games started in the year after RTP. The present investigation also demonstrated a significant reduction in game utilization during the year after RTP among players with Achilles repair, which was not demonstrated in healthy WNBA control players. Additionally, there was a significant drop in PER after RTP that exceeded the drop in PER seen in controls. Unfortunately, the sample size in the WNBA is presently too small to collect meaningful, longer-term data. As the WNBA continues to expand, it would be prudent for future studies to determine the long-term effects of ATR on performance, as reports on major male sports have demonstrated no significant performance difference past the first season after RTP.³³

Injury to the Achilles tendon is most common during recreational sporting activity, particularly in middle-aged patients of both sexes.³⁴ It is difficult to compare outcomes after ATR in women, as the incidence of injury is much lower than that in the male population, with some studies showing as few as 20% to 25% of ATRs occurring in women.^{10,11} The understanding behind the lower incidence of ATR in women is a matter of debate. Bryant et al³ examined the effect of long-term estrogen exposure on the Achilles tendon and found that there was decreased overall strain on the tendon compared with short-term exposure, which could account for less attritional wear of the tendon. Additionally, it has been postulated that estrogen exposure may cause an inhibitor effect on muscle fiber diameter; thus, it may be more difficult to produce the large eccentric contraction commonly attributed to be the mechanism of rupture.¹⁵ Outcomes after treatment for Achilles tendon tears have been reported to differ between the sexes. A study examining differences in outcomes between sexes after ATR found that, regardless of treatment, women had

significantly worse heel-rise height at 1 year, while those treated operatively reported significantly more symptoms compared with male counterparts.²⁹ Bruggeman et al² reviewed 167 Achilles tendon repairs and found that female sex was a significant risk factor for wound healing complications. This could account for some of the aforementioned differences in time to RTP. While the incidence may be lower in women, it is important for treating physicians to be aware of these sex-related differences when they do occur in female athletes.

There are limitations to this investigation. The use of publicly available sources is prone to reporting bias, especially as the coverage of female professional athletics is not given the same attention as male athletics in the United States. However, this method of data collection has been successfully employed in several investigations,^{25,33} and each reported injury was cross-referenced by multiple sources. While we only identified 12 total tears over the study period, multiple registry studies have reported significantly fewer ATRs in women compared with men, which may account for our relatively smaller sample size.^{5,7,11} Additionally, the incidence of ATR is understandably low in the young WNBA population, with the present study demonstrating a mean age of 28 years among ATR players. It is still possible that some Achilles tendon tears were missed, but we are confident that each tear was captured with our search methodology. The time of season that the tear occurred could have also influenced the time to RTP, which was not taken into account during this investigation.

There are also many factors that go into an athlete's performance, including health and quality of teammates and opponents, position, trades, and coaching; thus, changes in performance may be influenced by factors other than their injury. However, both player and control groups similarly face these challenges inherent to professional sports, and we believe that the control-matching process assisted in negating these differences. Additionally, the ability to RTP is multifactorial, and players may have elected to not return to the WNBA for reasons unrelated to their Achilles tendon injury, postoperative complications, or differences in postoperative rehabilitation. Female athletes may also RTP internationally more readily than male athletes, as the salary disparity between WNBA and international contracts is not as prevalent as it is with NBA players. We attempted to identify athletes from the present cohort who continued playing internationally, but many international leagues do not provide accurate statistics and therefore were excluded. Career longevity calculations may have been affected by this, as well as by players who are still in the league and not retired at this time. Finally, there were likely differences in the perioperative care of each athlete, including differences in surgical technique, postoperative rehabilitation, and RTP programs that were unable to be accounted for.

CONCLUSION

The majority of WNBA players who sustain ATR are able to return to sport after their injury; however, their career

longevity is shorter than that of healthy controls. There is a significant decrease in game utilization and performance in the year after RTP compared with healthy controls.

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