



Increased incidence of acute achilles tendon ruptures in the peri-pandemic COVID era with parallels to the 2021–22 NFL season

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Abstract

Purpose Acute Achilles tendon ruptures (AATRs) are a common sporting injury, whether for recreational athletes or elite athletes. Prior research has shown returning to physical activity after extended periods of inactivity leads to increased rates of musculoskeletal injuries. The purpose of this study was to investigate rates of acute Achilles' tendon ruptures at a single academic institute in the peri-COVID era, with corollary to the recent NFL season.

Methods A retrospective search was conducted using current procedural terminology to identify the total number of Achilles acute primary repair surgeries performed from years 2017 to 2021. Non-operatively managed AATRs were identified from the same electronic medical record using ICD-10 codes. NFL data were obtained from publicly available sites according to previously validated studies.

Results A total of 588 patients who sustained AATRs and underwent primary surgical repair were identified, primarily men (75.7%, $n=445$), with an average age of 43.22 ± 14.4 years. The number and corresponding incidence of AATR repairs per year was: 2017: $n=124$ (21.1%), 2018: $n=110$ (18.7%), 2019: $n=130$ (22.1%), 2020: $n=86$ (14.6%), 2021: $n=138$ (23.5%), indicating a 7.5% decrease in rate of AATRs from 2019 to 2020, followed by an 8.9% increase in incidence from 2020 to 2021. Within the NFL, the number of AATRs resulting in an injured reserve stint increased every regular season from 2019 to 2020: $n=11$ (21.2%), to 2020–2021: $n=17$ (32.7%), to this past 2021–2022 season: $n=24$ (46.2%).

Conclusion AATR surgeries seem to have increased in 2021 following a 2020 COVID pandemic-induced quarantine for recreational athletes at a single academic institution and for professional athletes in the NFL, although these results are of questionable clinical significance. This provides prognostic information when counseling patients and athletes on return to activity or sport.

Level of evidence Level IV.

Keywords Achilles tendon ruptures · COVID pandemic · National Football League · Epidemiology

Introduction

The World Health Organization declared the outbreak of COVID-19 a pandemic on March 11, 2020, leading to lockdowns, quarantines, and increased sedentary behaviors [4, 25]. A resultant increase in body mass index (BMI) from these decreased activity levels was seen in 2020 [7, 10, 13]. As the general population as well as athletes returned to their normal physical activities or sport in 2021, the risk for musculoskeletal injury increases after this period of quarantines and lockdowns [20]. As prior research has shown, returning to physical activity after extended periods of inactivity, from lockdown and a shortened preseason, leads to increased

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rates of musculoskeletal injuries; in runners, military, the National Football League (NFL), and Premier League athletes [1, 2, 12, 16, 29]. However, there have been no studies investigating rates of acute Achilles tendon ruptures (AATR) requiring repair in the peri-COVID era.

Previous studies have demonstrated that professional athletes are prone to Achilles tendon rupture. In the NFL, rates of AATRs spiked after the 2011 lockout in which players were unable to train normally in the offseason, similarly rates of AATR were seen to increase in the first few weeks of the 2020–2021 season due to the suspension of the 2020 preseason secondary to COVID concerns [2, 18].

Thus, the purpose of this study was (1) to investigate the rates of AATR in recreational athletes requiring repair in a single academic center in NYC, and (2) see if a corollary exists for professional athletes in the NFL. The hypothesis is that after a decrease in AATRs in 2020 from decreased physical activity due to a combination of lockdown sanctions and COVID pandemic-induced fears, there is a rebound increase in AATRs in 2021, possibly even to greater than pre-pandemic levels.

Materials and methods

A retrospective review was performed at a single urban academic institution after institutional review board approval (i19-01430). The electronic medical record (EMR) was queried for the following current procedural terminology (CPT) codes for Achilles tendon procedures from January 1st, 2017 to December 31st, 2021: Achilles tendon repair or reconstruction (27650, 27652, 27654). Non-operatively managed AATRs were identified using ICD-10 codes and reviewed to remove any managed surgically. Demographic information including age, gender, body-mass index (BMI), and smoking status were also obtained from the EMR query. All cases were reviewed by two independent authors and all cases that did not include an acute primary repair, or non-operative management were excluded. Acute primary repair is generally performed within 4 weeks from injury, although there is some variability depending on patient age, injury mechanism, tissue quality, and tendon retraction. All cases of tendon augmentation, reconstruction, or tendon transfer were excluded. To function as a control, the total number of surgeries performed by the Sports division at the same institution were also reported through the same study period.

Time analysis

For comparative analysis, the COVID era was estimated using the entirety of the year 2020. Pre-COVID era analysis was estimated as the years 2017–2019, and “post-COVID”, was considered the year 2021. Although the authors are fully

aware that the COVID pandemic continues to rage on, with new variants such as Delta and Omicron, as aforementioned 2021 brought an increased return to physical activity levels, especially during warmer months.

NFL analysis

A retrospective review of all NFL players who were placed on the injured reserve (IR) due to an Achilles injury were recorded for the 2019–2020, 2020–2021, and 2021–2022 NFL regular season. The data were compiled using publicly available injury reports (espn.com/nfl/injuries, nfl.com/injuries, pro-football-reference.com/players/injuries.htm) according to prior validated studies [2, 23]. The sources publish weekly NFL injury reports including player name, team, position played, injury, and injury designation (e.g., questionable, doubtful, out, IR). At least two sources were used to confirm injuries and only players placed on IR were recorded for severity. Data on Achilles NFL injuries for prior seasons were extrapolated from previously published studies using similar methods.

Statistical analysis

Descriptive statistics were completed consisting of mean and standard deviation for continuous variables and frequency and percentage for categorical variables. A 2×2 Chi-square analysis was conducted between proportion of Achilles surgeries performed in 2021 and 2017–2020. Additional 2×2 Chi-square analysis was performed in a similar manner, however, between each year and 2021. A value of $p < 0.05$ was considered statistically significant. All statistical analysis was performed using RevMan version 5.3 (The Nordic Cochrane Centre, Copenhagen, Denmark).

Results

A total of 1,431 patients sustained AATRs during the 5-year study period. The incidence of AATRs per year was; 2017: $n = 288$ (20.1%), 2018: $n = 261$ (18.2%), 2019: $n = 291$ (20.3%), 2020: $n = 196$ (13.7%), and 2021: $n = 395$ (27.6%) (Table 1). The breakdown of acute repairs and non-operative management can be seen in Table 1.

A total of 588 patients who sustained AATRs and underwent primary operative repair were identified in the 5-year study period (Table 1). There were 297 (50.5%) right AATRs and 291 (49.5%) left AATRs. The cohort was composed primarily of men (75.7%, $n = 445$), with an average age of 43.22 ± 14.4 years. The average BMI was 28.59 ± 6.0 kg/m², and 11.2% ($n = 66$) were current smokers. There was no significant difference with respect to demographics at any year.

Table 1 Achilles repair patient demographics and characteristics

	2021	2020	2019	2018	2017	Total
Number of achilles repairs (% of total surgical repairs)	138 (23.5%)	86 (14.6%)	130 (22.1%)	110 (18.7%)	124 (21.1%)	588
Number of acute achilles tendon ruptures (AATRs) treated non-operatively (% of total non-operative)	257 (30.5%)	110 (13.0%)	161 (19.1%)	151 (17.9%)	164 (19.5%)	843
Total AATRs (% of total number, % of AATRs treated surgically that year)	395 (27.6%, 53.7%)	196 (13.7%, 78.2%)	291 (20.3%, 80.7%)	261 (18.2%, 72.8%)	288 (20.1%, 75.6%)	1431
Avg Age ^a	40.8 ± 14.6	45.1 ± 14.1	43.6 ± 13.5	44.1 ± 14.8	43.3 ± 14.8	
Avg BMI ^a	28.0 ± 5.7	29.3 ± 6.7	29.2 ± 6.6	28.5 ± 5.6	28.2 ± 5.3	
Males ^a	106	64	100	83	92	445 (75.7%)
Females ^a	32	22	30	27	32	143 (24.3%)
Laterality (right left) ^a	73 65	43 43	64 66	59 51	58 66	297 291

Data shown as mean ± standard deviation unless otherwise indicated

^aDemographic information for surgically repaired AATRs only

The incidence of the total number of AATR repairs per year was; 2017: $n = 124$ (21.1%), 2018: $n = 110$ (18.7%), 2019: $n = 130$ (22.1%), 2020: $n = 86$ (14.6%), 2021: $n = 138$ (23.5%). There was a 7.5% decrease in rate of AATRs acute repairs from 2019 to 2020, followed by an 8.9% increase in incidence from 2020 to 2021. There was also a 2.9% increase in rate of AATRs from pre-COVID rates (mean from 2017 to 2019) to “post-COVID” rates in 2021.

Within the same institution, the overall number of sports surgeries over the same time period was: 2017: $n = 4189$ (22.0%), 2018: $n = 4085$ (21.5%), 2019: $n = 3810$ (20.0%), 2020: $n = 3261$ (17.2%), 2021: $n = 3660$ (19.3%) (Table 2). 2021 had a significantly higher proportion of AATR primary repairs when compared to 2020, 2018 and 2017, as well as when compared to 2017–2020 as a whole, but not when compared to 2019 (Table 2).

Table 2 Number of Achilles tendon rupture surgical repairs as well as total sports surgeries performed at a single academic institution from 2017 to 2021

	2021	2020	2019	2018	2017	2017–2020
Achilles repair	138	86	130	110	124	450
All other sports surgeries	3522	3175	3680	3975	4065	14895
Total	3660	3261	3810	4085	4189	15345
Percent achilles repair	3.77%	2.64%	3.41%	2.69%	2.96%	2.93%
<i>p</i> -value		0.008	n.s	0.007	0.03	0.009

The *p*-values reported signify chi-squared analysis between each year and 2021

NFL results

Within the NFL, the number of AATRs resulting in an injured reserve stint increased every regular season from 2019–2020: $n = 11$ (21.2%), to 2020–2021: $n = 17$ (32.7%), to this past 2021–2022 season: $n = 24$ (46.2%) (Fig. 1). These numbers were compared with rates of AATRs sustained in the NFL during prior seasons extrapolated from prior studies, as listed in the figure [14, 18, 21].

Discussion

The main finding of this study is a decrease in the incidence of AATRs surgeries during the height of the COVID pandemic quarantine in 2020, with a 13.9% increase in “post-COVID” 2021 compared to 2020 at a single academic institution. There was also a 8.1% higher incidence of AATR surgeries in 2021 compared to “pre-COVID” normal levels when averaged between 2017 and 2019, findings that are

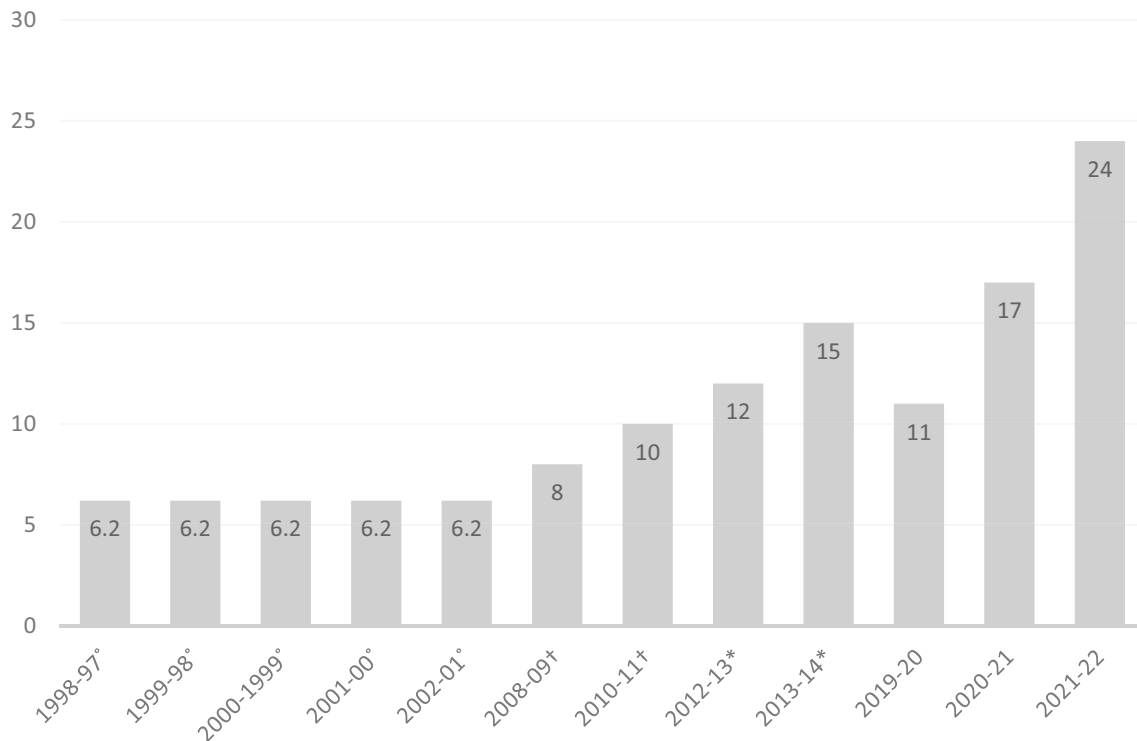


Fig. 1 Number of acute Achilles tendon ruptures occurring in the National Football League regular seasons from 1998 to 2022. Additional numbers of acute Achilles tendon ruptures for prior years are

listed from prior studies as cited within the figure. *From Lawrence et al., *OJSM* 2015 [14]. †From Myer et al., *JOSPT* 2011 [18]. °Averages from Parekh et al., *Foot and Ankle Specialist* 2009 [21]

mirrored in the NFL, with the most recent 2021–2022 regular season having 24 AATRs leading to significant time lost to IR. The only comparison that did not lead to a significant increase in 2021, was to 2019. However there was a trend toward an increase in AATR surgeries, and significance may be an artifact of sampling. Interestingly, there was no change in rate of surgical management of AATRs during 2020, suggesting that despite fears of healthcare settings during the height of the COVID pandemic, AATRs were treated more similarly to trauma cases than elective cases. This may be due to a variety of reasons, such as limited access to rehabilitation centers or a reduced ability for close follow up and monitoring of non-operatively managed AATRs. AATRs managed surgically had a 8.9% increase in “post-COVID” 2021 compared to 2020 at a single academic institution. There was also a 2.9% higher incidence of AATR repairs in 2021 compared to “pre-COVID” normal levels when averaged between 2017 and 2019.

Surprisingly, there are limited investigations on increased rates of musculoskeletal injury following the COVID pandemic quarantine and lockdown in 2020. This is especially true pertaining to AATR injuries, which are particularly prone to disuse, atrophy, and tendinosis [15, 20]. Roopnarinesingh et al. published a small case series of three patients who sustained AATRs over a ten-day period in 2021, all

due to the ‘Jerusalem’ dance, and highlighted the importance of precautions when returning from COVID induced lack of physical activity to deceptively demanding physical activity [27]. An investigation by Baker et al. demonstrated that NFL injuries spiked significantly in the first four weeks of the 2020–2021 regular season after the 2020 preseason was canceled due to the COVID pandemic [2]. A similar trend of increased NFL injuries occurred after a period of inactivity during the 2011 lockout as reported by Myer et al. [18]. They reported on two prior studies that found AATR occurred at an average of 5–6 per year from 1980 to 2001 and 1997 to 2002, whereas in training camp and the first two weeks of preseason following the 2011 lockout, 12 AATRs had already occurred.

The Achilles tendon may be particularly prone to rebound increase in ruptures following periods of inactivity given its unique anatomical and functional structure [11, 17]. Multiple animal model studies have demonstrated tendinosis-like microscopic changes in the unloaded Achilles tendon, either through immobilization or denervation [5, 6, 8, 9, 17]. Tendon physiology and composition has been shown to respond to the level of mechanical load being applied [3]. Multiple studies, in both human and animal models, have shown loss of elasticity in the tendon after reduction in mechanical stress. Functionally, the loss in tendon elasticity may

not affect the force output, however, it may reduce the efficiency in which energy is transferred to the skeletal system [26]. Yamamoto et al. studied the effects of unloading on the patella tendon in rabbits and on histologically preparation found after two weeks the collagen fibers became more disorganized and there was an increase in fibroblasts [30]. Similar findings were observed in a rat Achilles model, Nakagawa et al. reported after 5 weeks of disuse the collagen in the tendon had remodeled to a disorganized pattern compared to normal collagen orientation in a mechanically loaded model [19]. There was an overall decrease in surface area and diameter of collagen fibers, leading to decrease in tensile strength.

The current study has shown a large increase in the number of AATR in recreational athletes as well as professional athletes following a period of extended rest. It would be expected that in both groups increased attention should be paid to prevent these injuries. Stretching is one of the most popular conventional modalities used to prevent injuries. However, there is limited scientific evidence to support stretching and, on the contrary, may even lead to deleterious effect [22]. Some studies have shown the compressive load in stretching may induce tendinopathy [22]. However, there is evidence supporting the use of balance and proprioception training in preventing tendinopathy. Kraemer et al. implemented a soccer specific balance training program in female Premier League athletes, and over a 3-year period found a significant decrease in rates of Achilles tendinopathy [24]. Other preventative modalities such as shoe modification and orthotics have also been discussed in the literature with mixed results. Overall, prevention of tendinopathy is a complex topic because modalities aim to correct a finite number of factors while the etiology of tendinopathy is often multifactorial [22, 28]. Further longer term studies with large cohorts are needed to appropriately construct preventative protocols.

This study is not without limitations. Using CPT codes for acute Achilles repairs, only a simple estimate of the rate of AATR is derived, as not all AATR are indicated for surgery or end up having the procedure done at this institution. The majority of AATR are repaired acutely at our institution, unless there are medical comorbidities, therefore reducing this confounder. Many patients moved out of the city during the pandemic, in particular 2020, which may contribute to lower rates of surgery within our institution. AATR are also pathologies that can be reasonably treated non-operatively, and thus less aggressive operative management of these injuries may have occurred during 2020 when parts of the year were canceling elective surgeries due to COVID. In regard to the NFL data, this study is limited that for all seasons prior to the 2019–2020 season, data were utilized from prior published studies, and thus the data are only as accurate as those original publications.

Conclusions

AATR surgeries seem to have increased in 2021 compared to 2020, following a period of inactivity and sedentary behavior induced by the COVID pandemic, demonstrated both at a single academic institution and in the NFL. This information provides prognostic information for orthopedic surgeons, sports medicine physicians, primary care providers, physical therapists, and athletic trainers when counseling patients and athletes on return to sport and athletic activity following prolonged periods of immobilization and sedentary behavior.

Author contributions ASB participated in data collection, statistical analysis, figures editing, and manuscript writing. MTA participated in data collection, statistical analysis, figures editing, and manuscript writing. JJJ participated in statistical analysis, figure editing and manuscript writing. MJA participated in study design and manuscript editing, LMJ participated in study design and manuscript editing, GGL participated in study design and manuscript editing, JGK participated in study design and manuscript editing. All authors read and approved the final manuscript.

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Data availability statement The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Conflict of interest The authors report the following potential conflicts of interest or sources of funding: MJA is a consultant for Arthrex and Mitek. MJA reports as a board or committee member for the American Academy for Orthopedic Surgeons and Arthroscopy Association of North America. LMJ received research support from Arthrex, Mitek, and Smith & Nephew. JGK is a consultant to Arteriocyte Industries (Isto Biologics) and Arthrex, and receives support from Ohnell Family Foundation, Mr. and Mrs. Michael J. Levitt and Mr. Winston Fisher. JGK reports as a board or committee member for the American Orthopaedic Foot and Ankle Society, European Society of Sports Traumatology, Knee Surgery and Arthroscopy, Ankle and Foot Associates, and International Society for Cartilage Repair of the Ankle.

Ethical approval Ethical approval was obtained from the institution's IRB.

Informed consent Informed consent was not required as this manuscript is a retrospective chart review study.

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