Racial Differences in Tendon Rupture Incidence

Authors B. Owens[1], S. Mountcastle[2], D. White[3]

Affiliations
[1] Department of Orthopaedic Surgery, Keller Army Hospital, West Point, NY, USA
[2] Department of Orthopaedic Research, Keller Army Hospital, West Point, NY, USA
[3] Department of Orthopaedic Surgery, Tripler Army Medical Center, Honolulu, HI, USA

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Abstract

Despite some anecdotal evidence, the racial differences in tendon injuries have received little attention in the literature. We sought to determine the effect of race on major tendon injuries. A search was performed according to the International Classification of Diseases, Ninth Revision, Clinical Modification code 727.65 (rupture of quadriceps tendon), 727.66 (rupture of patellar tendon), and 727.67 (rupture of Achilles tendon) using the U.S. Defense Medical Epidemiology Database (DMED). Multivariate poisson regression was used to estimate the rate of major tendon rupture per 1000 person-years, while controlling for differences in gender, service, rank, and age for each code. We computed rate ratios and 95% confidence intervals using whites as the referent category. The adjusted rate ratio for black service members when compared to white service members was 2.89 (95% CI 2.42, 3.44) for quadriceps tendon tears, 4.52 (95% CI 3.94, 5.19) for patellar tendon tears, and 3.58 (95% CI 3.31, 3.88) for Achilles tendon tears. There appears to be a significant relative predisposition toward lower-extremity major tendon rupture in black U.S. service members when compared to white service members. Investigation of the racial differences in risk factors is warranted.

Introduction

Lower extremity major tendon ruptures are a significant problem in sports. The incidence of Achilles tendon ruptures has been documented at 2.66 per 1000 person-years over a four-year period of study in Malmo, Sweden, with the peak incidence in the third and fourth decades of life [15]. Approximately two-thirds of Achilles tendon ruptures occur during sporting activity [8,15].

In addition to sports injuries, major tendon ruptures in the lower extremity occur as a result of non-traumatic mechanisms. These injuries are rarer and seem to occur in older patients with comorbidities such as renal disease and autoimmune disorders [5]. The risk factors for tendon ruptures in otherwise healthy patients are less clear. There have been associations with blood groups and certain genetic polymorphisms [7,8,14]. One previous study showed an increased incidence of Achilles tendon ruptures in individuals of black race, compared to nonblacks [1]. We sought to investigate the racial differences in major tendon rupture incidence using a large military database.

Methods

The Defense Medical Epidemiology Database (DMED) compiles International Classification of Diseases, Ninth Revision, and Clinical Modification (ICD-9-CM) coding information for every patient encounter occurring in a U.S. military treatment facility, in addition to maintaining the total number of U.S. soldiers on active duty each year. This database also contains patient demographic and military-specific data which can be used for epidemiological purposes. Race data is routinely obtained from the Defense Manpower Data Center (DMDC), which compiles service members' self-report of race with the following options: white, black, Hispanic, Alaskan native/American Indian, Asian/Pacific Islander, and other. DMED classifies these categories into 3 larger groups: white, black, and other. Mixed race individuals were classified according to self-report.

To determine the total number of major tendon ruptures, we queried the DMED system by race, gender, military service, rank, and age for the years 2000 – 2004 using the following ICD-9 CM codes: 727.65 (rupture of quadriceps tendon),

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Correspondence
Brett Owens, MD
Department of Orthopaedic Surgery
Keller Army Hospital
West Point, New York
USA
b.owens@us.army.mil

Table 1 Number of quadriceps, patella, and Achilles tendon injuries by race among United States Armed Forces service members between 2000 and 2004 and the total number of service members in the Armed Forces during this time period by race using the DMED Database

	Number of injuries	Number of exposures	Unadjusted RR (95% CI)*	Adjusted RR (95% CI)†
Quadriceps				
▶ Black	242	1376178	2.79 (2.36, 3.31)	2.89 (2.42, 3.44)
▶ Other	44	667280	1.05 (0.76, 1.44)	1.09 (0.79, 1.49)
▶ White	298	4728407	N/A	N/A
Patella				
▶ Black	508	1376178	4.50 (3.94, 5.13)	4.52 (3.94, 5.19)
▶ Other	57	667280	1.04 (0.79, 1.37)	1.06 (0.80, 1.40)
▶ White	388	4728407	N/A	N/A
Achilles				
▶ Black	1347	1376178	3.35 (3.11, 3.61)	3.58 (3.31, 3.88)
▶ Other	185	667280	0.95 (0.81, 1.11)	1.10 (0.94, 1.28)
▶ White	1382	4728407	N/A	N/A

* White is referent category. † Adjusted for age, service, rank, and gender

Table 2 Unadjusted and adjusted rates and rate ratios of quadriceps, patella, and Achilles tendon injuries by gender among United States Armed Forces service members between 2000 and 2004

	Unadjusted rate (per 1000 person-years)	Unadjusted RR (95% CI)*	Adjusted rate (per 1000 person-years)	Adjusted RR (95% CI)†
Quadriceps				
▶ Male	0.093	1.86 (1.39, 2.48)	0.091	2.03 (1.51, 2.72)
▶ Female	0.050		0.045	
Patella				
▶ Male	0.154	2.37 (1.85, 3.05)	0.134	2.83 (2.20, 3.65)
▶ Female	0.065		0.047	
Achilles				
▶ Male	0.464	1.95 (1.71, 2.23)	0.455	2.23 (1.95, 2.55)
▶ Female	0.670		0.204	

* Female is referent category. † Adjusted for age, service, rank, and race

727.66 (rupture of patellar tendon), and 727.67 (rupture of Achilles tendon). The race categories were white, black, and other. The service categories used were Army, Navy, Air Force, and Marines. The rank categories we used were E1 – E4, E5 – E9, O1 – O3, and O4 – O9. The age categories used were < 20, 20 – 24, 25 – 29, 30 – 34, 35 – 39, and ≥ 40. Inpatient data were excluded to capture only ambulatory encounters. Events were limited to a "first occurrence" to exclude repeat coding of the same initial injury for all services during the study period. The database was also queried for the total number of service members on active duty during the study time period by race, gender, service, rank, and age. One exposure year was defined as one year that the service member was in the Armed Forces.

We used multivariate Poisson regression to estimate the rate of major tendon injury per 1000 person-years by race for each ICD-9 code (unadjusted rates). We also determined the rate per 1000 person-years by race, controlling for age, gender, service, and rank for each ICD-9 code (adjusted rates). We computed adjusted and unadjusted rate ratios and 95% confidence intervals (CI), using whites as the referent category. We also present the adjusted and unadjusted rates and rate ratios for gender and age using females and those < 20 as the referent groups, respectively. Statistical analysis was performed using SAS software version 9.1 (Cary, NC, USA).

Results

There were a total of 4451 major tendon ruptures in the lower extremity during the study time period and a total of 6771865 service member-years among black, white, and other service members. The injury rate, adjusted for gender, rank, service, and age differences, for quadriceps tendon was 0.126 tears (per 1000 person-years) for black service members, 0.047 for those categorized as other, and 0.044 for white service members; the adjusted rate ratio was 2.89 (95% CI 2.42, 3.44) for black service members when compared to white service members and 1.09 (95% CI 0.79, 1.49) for service members categorized as other when compared to white service members (**Table 1**). The adjusted incidence rate for patellar tendon injuries was 0.213 for black service members and 0.050 for race category other, and 0.047 for race category white; the adjusted rate ratio was 4.52 (95% CI 3.94, 5.19) for black service members when compared to white service members and 1.06 (95% CI 0.80, 1.40) for service members categorized as other when compared to white service members (**Table 1**). The adjusted injury rate for Achilles tendon tears was 0.692 for black service members, 0.212 for those categorized as other, and 0.193 for white service members; the adjusted rate ratio was 3.58 (95% CI 3.31, 3.88) for black service members when compared to white service members and 1.10 (95% CI 0.94, 1.28) for service members categorized as other when compared to white service members (**Table 1**).

Table 3 Unadjusted and adjusted rates and rate ratios of quadriceps, patella, and Achilles tendon injuries by age group among United States Armed Forces service members between 2000 and 2004

	Unadjusted rate (per 1000 person-years)	Unadjusted RR (95% CI)*	Adjusted rate (per 1000 person-years)	Adjusted RR (95% CI)†
Quadriceps				
▸ < 20	0.043	N/A	0.028	1.44 (1.51, 2.72)
▸ 20 – 24	0.059	1.39 (0.91, 2.13)	0.040	2.11 (0.94, 2.21)
▸ 25 – 29	0.078	1.83 (1.18, 2.83)	0.059	2.46 (1.32, 3.37)
▸ 30 – 34	0.088	2.07 (1.33, 3.23)	0.070	4.10 (2.47, 6.80)
▸ 35 – 39	0.146	3.44 (2.24, 5.27)	0.115	4.62 (2.73, 7.80)
▸ > 40	0.146	3.45 (2.22, 5.34)	0.129	
Patella				
▸ < 20	0.048	N/A	0.031	N/A
▸ 20 – 24	0.087	1.82 (1.22, 2.71)	0.056	1.79 (1.20, 2.67)
▸ 25 – 29	0.153	3.22 (2.17, 4.78)	0.094	3.01 (1.98, 4.57)
▸ 30 – 34	0.191	4.02 (2.70, 5.97)	0.109	3.49 (2.25, 5.41)
▸ 35 – 39	0.224	4.70 (3.16, 6.97)	0.122	3.91 (2.51, 6.10)
▸ > 40	0.190	3.99 (2.65, 6.00)	0.115	3.68 (2.32, 5.85)
Achilles				
▸ < 20	0.104	N/A	0.107	N/A
▸ 20 – 24	0.155	1.49 (1.14, 1.96)	0.150	1.40 (1.07, 1.84)
▸ 25 – 29	0.377	3.64 (2.79, 4.74)	0.309	2.89 (2.18, 3.83)
▸ 30 – 34	0.690	6.66 (5.13, 8.65)	0.504	4.71 (3.53, 6.29)
▸ 35 – 39	0.808	7.79 (6.00, 10.12)	0.552	5.16 (3.85, 6.92)
▸ > 40	0.836	8.07 (6.12, 10.50)	0.582	5.44 (4.03, 7.34)

* Age < 20 is referent category. † Adjusted for gender, service, rank, and race

Males had a higher rate of injury when compared to females after adjusting for race, age, rank, and service (**Table 2**). Increased age also appeared to be associated with higher rates of tendon injury when compared to those < 20 years of age (**Table 3**).

Discussion

We found a significantly higher incidence of major tendon rupture among black soldiers when compared to white soldiers over a four-year time period using a large military database. This supports the findings of Davis et al. who found an increase incidence of Achilles tendon injuries undergoing surgical repair in black U.S. soldiers [1]. While their study is limited to a 3 year review of Achilles tendon injuries treated operatively in military hospitals, the findings of the current study using a large database encompassing all lower extremity tendon ruptures further strengthens the argument that there does appear to be a relative increased incidence of lower extremity tendon injuries in black U.S. soldiers compared to white U.S. soldiers.

There are many potential reasons for the racial differences in tendon injuries. A recent biomechanical study of the viscoelastic properties of Achilles tendon-gastrosoleus complex showed a higher stiffness in black athletes [2]. The authors proposed this to be an explanation of the superior sprinting/jumping performance seen in black athletes. These differences could also result in tissue that is more likely to undergo catastrophic failure if subjected to sufficient trauma.

There has also been a reported link between ABO blood group O and an increased risk for tendon rupture [7 – 9]. However, other reports, also from Europe, have not shown this association [10, 13]. A recent report took this potential risk factor of blood type O and analyzed its association with the gene for the tenascin-c protein, which is closely linked to the ABO gene. These authors found an increased risk for Achilles tendon injury among individuals who possessed a certain repeat polymorphism within the tenascin-c gene [14].

There are no published reports evaluating the link of ABO blood grouping and tendon injuries with the population in North America. However, we do know that there are ABO differences among different races in the United States, with blacks having a higher percentage of individuals with type O blood than whites (50.2% versus 45.2%) [3]. Future studies should explore this phenomenon in a large database such as the DMED.

Racial differences in body weight have been reported. Obesity has been reported to be more prevalent in black adults than Caucasian adults in the United States [17]. This trend has also been noted in an active duty U.S. military cohort [12]. However, physical activity was not found to be independently linked to being overweight. Increased body weight has been linked to an increase in overuse injuries in military recruits [4]. Body weight data was not available in our current study, therefore we are unable to determine the effect of this parameter on tendon ruptures in our population. Activity level data was also not available in our study, therefore we cannot comment on its potential effect on our results. The availability of occupation data could assist in the inference of activity level. However, in the study by Davis et al. [1], a majority of Achilles ruptures occurred during play of basketball, an off-duty activity.

We also found males had a higher tendon rupture rate when compared to females. There are previous reports detailing the clear male predominance in these injuries [6,7,16]. While these results support male gender as a risk factor for lower extremity tendon rupture, it is unclear whether activity patterns or body weight may have influenced these results. Athletic exposure data, not just number of person-years in the Armed Forces, would be needed to completely eliminate this potential bias.

We also found that increased aged was an independent risk factor for major lower extremity tendon rupture. This is consistent with other reports that show a peak in Achilles tendon ruptures

in the third decade of life [7,15]. It is unclear whether body weight or activity level may have effected these results.

This study has both strengths and weaknesses. The greatest strength of this study is the large number of young, active individuals whose injuries are annotated in the DMED database. This allows for comparison of demographic groups. However, the quality of the data in any large database is only as good as the data entry. This database uses data generated from the coding of ambulatory and inpatient visits. We chose to evaluate only the ambulatory data, as the inpatient numbers were significantly lower. The data entered into the database from an ambulatory report relies on the accurate ICD-9 coding of injuries, which is suspect to occasional errors. The addition of athletic exposure and mechanism of injury information would allow better comparison of relative risk and this concern with the DMED system has been noted by other authors [11]. However, this information would be difficult to obtain on such a large population and currently is not available. The addition of ABO blood type information would also be beneficial to analyze, however, this information is currently not available with the DMED database.

Conclusion

There appears to be a predisposition among black U.S. service members toward lower extremity major tendon rupture. Currently, it is not possible to determine if race itself is a risk factor or is a proxy for as associated intrinsic or behavioral factor. Continued study of risk factors for tendon rupture is needed.

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