Increase in Achilles Tendon Rupture Surgery in Japan

Results From a Nationwide Health Care Database

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Background: Nationwide epidemiologic studies in Scandinavian countries have shown that the incidence of Achilles tendon ruptures (ATRs) has increased, and the rate of surgical treatment has declined markedly in the past decade. However, there is a lack of national-level data on the trend of ATRs and surgical procedures in other regions.

Purpose: To clarify the trend in the incidence of ATRs and the proportion of surgery using the nationwide health care database in Japan.

Study Design: Descriptive epidemiology study.

Methods: Age- and sex-stratified data on the annual number of ATRs and surgical procedures between 2010 and 2017 were obtained from the Japanese national health care database, which includes almost all inpatient and outpatient medical claims nationwide. The Japanese population data were also obtained from the population census. The change in the annual incidence of ATRs per 100,000 people was assessed using a Poisson regression analysis. The trend in the annual proportion of surgeries relative to the occurrence of tendon ruptures was determined using a linear regression analysis.

Results: A total of 112,601 ATRs, with men accounting for 67%, were identified over 8 years. Patients aged ≥60 years accounted for 27,106 (24%), while those aged 20 to 39 years and 40 to 59 years accounted for 36,164 (32%) and 49,331 (44%), respectively. The annual incidence of ATR ranged from 12.8/100,000 to 13.9/100,000 (women, 8.2-8.9/100,000; men, 17.2-19.5/100,000), which did not change over the study period ($P = .82$). Moreover, the annual incidences did not change across sexes and age categories. The annual proportion of surgery increased significantly, from 67% in 2010 to 72% in 2017 ($P = .003$). The annual proportions increased across sexes and age categories except for women aged 40 to 59 years.

Conclusion: The incidence of ATR did not change between 2010 and 2017, according to the Japanese nationwide health care database. Furthermore, the proportion of surgical treatment increased during the study period. Overall, 70% of patients underwent surgical treatment. This study suggested that the trend in ATR and surgery differed across regions.

Keywords: Achilles tendon; Achilles tendon rupture; Achilles tendon rupture incidence; Achilles tendon surgery; epidemiology; foot; national database; tendon rupture

Achilles tendon rupture (ATR) is the most common tendon rupture,[4] with the majority of injuries occurring during high-impact sports activities.[17] The incidence of injury is higher in men than in women, with a ratio of 2.9-5.7 to 1.[9] Tendon ruptures tend to occur during the third and fourth decades of life because of preexisting degeneration of the tendon.[11]

Many studies have reported an increasing trend in the incidence of ATR because of a larger number of the older population participating in sports activities.[12,17,19,24,28,32,34] However, most of these reports were based on data collected from hospitals,[12,17,19,24,28,34] local governments,[32] and health care databases that are restricted to a limited population.[6,18] Therefore, their results cannot be generalized to a national level. Only a few nationwide surveys, which provide more comprehensive and reliable information, are available.[9,15,21] In the national registry data from Denmark and Sweden, the overall incidence increased during the late 1990s and early 2010s.[9,15] This increase was

mainly because of a rise in the older population.[9,15] However, age composition is different among countries, and the level of sports participation as well as the preferred type of sport are different among regions.[14] Consequently, whether the increased incidences of ATR observed in Scandinavian countries would also occur in other areas remains unclear.

The treatment of ATR is either surgical or nonsurgical, and there has been a debate on which is the better treatment.[7,29,43] Recent randomized controlled trials have demonstrated that nonsurgical treatment using a functional brace with early weightbearing and range of motion provided satisfactory clinical results equivalent to those of surgical treatment.[33] These nonsurgical treatments also offer a reduced risk of complications associated with surgery, such as surgical site infections.[33] On the other hand, surgical treatment appears to reduce the risk of rerupture and may allow earlier return to sport and work.[7,29,33,43] In response to these trials, the number of surgeries for ATR has declined since 2010 in the Scandinavian countries, which include Denmark, Finland, and Sweden.[9,15,22] Conversely, the proportion of patients who received surgical treatments increased slightly during a similar time period in the United States and Italy,[20,41] although those studies were based on health care databases that cover only a part of the country's population.[20,41] Therefore, the change in the treatment method in response to clinical evidence seems to differ among countries. To date, except in the Scandinavian countries,[9,15,22] there is a lack of national-level data available on the trend in the surgical treatment of ATR.

The purpose of this study was to elucidate the trend in the incidence of ATR and surgical treatments using the nationwide health care database in Japan. We hypothesized that the incidence of ATR was stable and that the proportion of surgical treatment increased in Japan, in contrast to Scandinavian countries.

METHODS

Study Design

The research ethics committee of our institute approved this study. We obtained only anonymous, cross-tabulated data; therefore, informed consent was not required. This was a population-based retrospective cohort study conducted using the National Database of Health Insurance Claims and Specific Health Checkups of Japan (NDB),

provided by the Ministry of Health, Labour and Welfare for research purposes. The NDB contains all medical diagnoses and procedures as medical claims data. In Japan, the NDB includes all universal health coverage claims except for accidents covered by automobile liability insurance and workers' compensation, thus it is considered to represent almost all inpatient and outpatient medical claims in Japan.[10] In the NDB, the medical diagnoses are registered according to the International Classification of Diseases, 10th Revision (ICD-10), and the types of surgery performed are recorded according to a unique procedural coding system. The data also contain patient information, such as sex and age. The NDB has been used previously in epidemiologic studies on orthopaedic disorders, such as hip fractures and meniscal injuries.[16,37]

Data Collection

Data on the incidence of ATR and surgical treatments within an 8-year time frame (from April 2010 to March 2017) were obtained from the NDB. As information derived from a health care administrative database can be inaccurate because of erroneous miscoding of diagnoses,[38] procedural codes were used in combination with the diagnostic codes to improve accuracy.[2,13] We defined patients with acute ATR as those who met the following criteria: (1) ICD-10 code S860 (ATR) was registered; and (2) one of the following medical procedural and material codes was registered in the same month of the first clinic visit: J122 (plaster cast of the lower extremity), 056 (splint of the lower extremity), or K037-2 (surgery for ATR). This definition assumed that patients with ATR either underwent fixation with a cast or splint or underwent surgery as an initial treatment. We defined a patient who received acute Achilles tendon (AT) surgery as someone registered with both the procedural code K037-2 and the ICD-10 code S860. The second criterion was implemented to exclude patients who underwent surgery for chronic ruptures, which is coded as ICD-10 T935.

Patients with multiple registry entries were scored as having only 1 rupture/surgery because of the inability to determine whether the second entry was the result of a new rupture in the contralateral AT or a complication (such as a rerupture) in the index AT.[9,15,28] Patients aged <20 years were excluded, as the etiology and treatment options for this population can be different from those of adults.[41] The data on the number of ATR and surgery were provided in the form of a cross-tabulated table stratified by sex, age (categorized by 5-year intervals), and fiscal year. The

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TABLE 1
Annual Incidence of ATR and Proportion Treated Surgically in Japan, 2010-2017[a]

	2010	2011	2012	2013	2014	2015	2016	2017	P
Incidence, per 100,000	12.9	12.8	13.5	13.5	13.4	13.9	13.7	13.6	.82
Proportion of surgery, %	67	68	69	70	72	72	71	72	**.003**

[a]The bolded P value indicates a statistically significant difference over the study period (P < .05). ATR, Achilles tendon rupture.
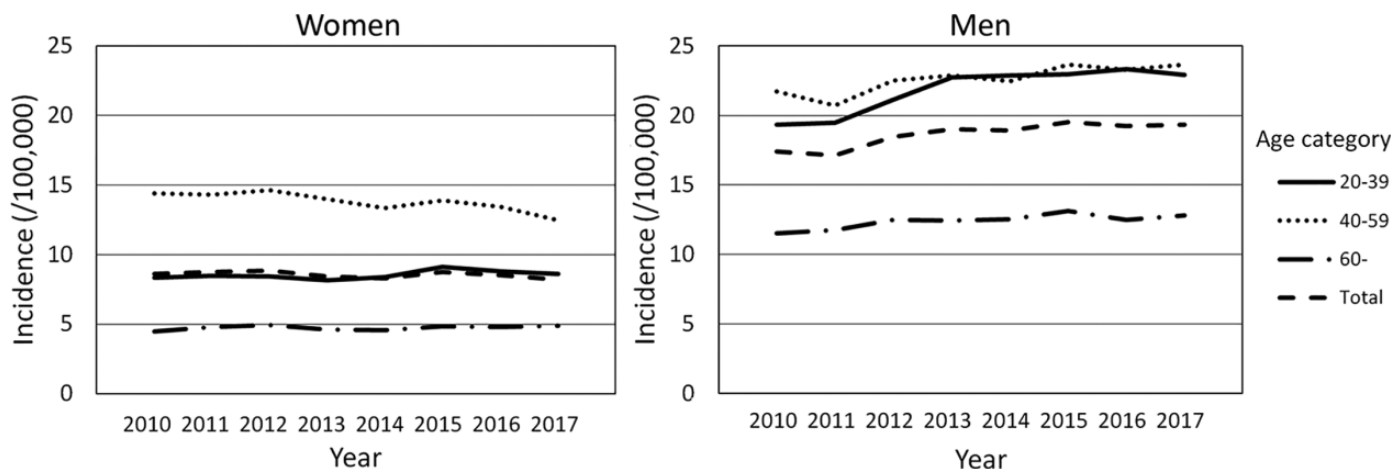

Figure 1. Annual incidence of Achilles tendon rupture (per 100,000 people) by sex and age category.

age- and sex-stratified Japanese population data were collected from the Ministry of Internal Affairs and Communications of Japan on October 1st of each year.[31]

Statistical Analysis

Descriptive statistics were used to express patient characteristics. The annual incidence of ATR per 100,000 people was calculated. The overall incidence, as well as those stratified by sex and age category, was calculated. Patient age was categorized into 3 groups: 20 to 39, 40 to 59, and ≥60 years.[15,22] The annual proportion of AT surgery was calculated as the number of procedures divided by the number of ruptures for each year. The change in the incidence of ATR was assessed using a Poisson regression analysis. The trend in the proportion of AT surgery was determined using a linear regression analysis. Results were considered statistically significant at P < .05.

RESULTS

A total of 112,601 ATRs were identified between April 2010 and March 2017, with men accounting for 67% (n = 75,334) of ruptures. The mean annual incidence during these 8 years was 13.4/100,000 (women, 8.5/100,000; men, 18.6/100,000). The median age category was 45 to 49 years in all fiscal years and in both sexes. Patients aged ≥60 years accounted for 24% (n = 27,106) of the incidence count, while those aged 20 to 39 and 40 to 59 years accounted for 32% (n = 36,164) and 44% (n = 49,331), respectively.

Overall, the annual incidence of ATR ranged from 12.8/100,000 to 13.9/100,000 and did not change over the study period (rate ratio [RR], 1.02 [95% CI, 0.92-1.13]; P = .82) (Table 1). The annual incidences also did not change across sexes or age categories (P = .41-.93). The incidences in women overall were between 8.2/100,000 and 8.9/100,000 (RR, 0.99 [95% CI, 0.90-1.10]; P = .91), while those in men overall were between 17.2/100,000 and 19.5/100,000 (RR, 1.02 [95% CI, 0.95-1.09]; P = .63) (Figure 1 and Appendix Table A1).

During the study period of 8 years, 79,033 AT surgical procedures were registered, for a mean annual incidence of 9.4/100,000 (women, 5.8/100,000; men, 13.3/100,000). The median age category of surgically treated patients was 45 to 49 years for all fiscal years, except for 2014, at 40 to 44 years.

The overall proportion of AT surgery relative to tendon rupture was 70% (women, 68%; men, 71%). We found that the proportion of surgical treatments increased significantly over a span of 8 years, from 67% in 2010 to 72% in 2017 (standardized partial regression coefficient = 0.007; P = .003) (Table 1). This increase was seen in both sexes and across all age categories (P = .03-.003), except for women aged 40 to 59 years (P = .06) (Figure 2 and Appendix Table A2). In women overall, the annual proportion increased from 65% in 2010 to 69% in 2017 (standardized partial regression coefficient = 0.007; P = .004), whereas in men overall, it increased from 68% in 2010 to 73% in 2017 (standardized partial regression coefficient = 0.007; P = .006) (Figure 2 and Appendix Table A2).

Figure 2. Annual proportion of Achilles tendon rupture treated surgically by sex and age category.

DISCUSSION

Using a nationwide health care database, we showed that the incidence of ATR in Japan did not change between 2010 and 2017. Furthermore, 70% of patients with ATR underwent surgery, with the proportion of surgical treatment increasing over the study period. The increasing surgical rate was different from the decreasing rates observed in other regions.

In this study, the mean annual incidence of ATR was 13.4/100,000. This figure was much lower than that reported in recent population studies in Denmark, Sweden, and Ontario,[9,15,32] which showed the annual incidence ranging from 29/100,000 to 35/100,000 in the 2010s. Several factors can explain the low incidence in Japan. First, the prevalence of obesity, which is a possible risk factor for ATR,[3] is lower in Japan than in the European countries.[1,25] While the prevalence of obesity is more than 20% in the European countries and the United States, it is only 4.5% in Japan.[1,25] Second, the proportion of people who engage in regular sports activities is lower in Japan than in the Scandinavian countries,[8,36] and this could have further reduced the risk of ATR.[27] In addition, our algorithm for defining patients with ATR from the database might have affected the incidence.[2,13] In the studies that reported higher incidences,[9,15,32] only the presence of the ICD-10 code S860 was used to extract the patients. To improve the diagnostic accuracy, we used the procedural and material codes in addition to the diagnostic code to define patients as having ATR, which might have resulted in a lower incidence rate.

Results showed that the annual incidences of ATR in Japan did not change across sexes and age categories. However, contrary to our results, previous studies have consistently observed an increased incidence of ruptures in the older age category (≥60 years) possibly because of the growing number of older adults participating in high-demand competitive and recreational sports.[9,15,32] Although the rate of regular sports participation has been increasing among Japanese older adults as well,[35] the differences seen in the trend of ATR might be because of the difference in the type of sports activity performed. While many European

and American adults enjoy higher-impact sports such as soccer and basketball,[14] Japanese adults appear to prefer mild- to low-impact sports, in which the risk of ATR is lower.[35] Further research is necessary to determine the worldwide trend in the incidence of ATR and factors associated with the trend.

In this study, the proportion of AT surgery was about 70% in Japan. Moreover, the annual proportion increased over the 8-year study period. Similar to our study, 61% of patients received surgical treatment in a study of a US health care database.[41] However, our results are in contrast to the nationwide-level registry data from the Scandinavian countries, which show that the number of surgical procedures has declined markedly, by more than one-half, between 2007 and 2013.[9,15,22] The decrease in the number of surgical treatments was also observed in a cohort study of Ontario residents.[32] In these regions, the proportions of surgery ranged from 20% to 31% in 2013.[9,15,32]

A possible explanation for this discrepancy is that studies favoring nonsurgical treatments were also reported from the Scandinavian countries and Canada,[26,30,33,42] which changed the clinical practice in these countries. However, physician treatment policy and medical practices in other countries, including Japan, have not changed in response to these studies. Indeed, the results of high-quality randomized controlled trials do not always lead to a change in clinical practice. For example, the surgical method for distal radius fractures shifted from volar locking plate to K-wire fixation in the United Kingdom after the results of the Distal Radius Acute Fracture Fixation Trial performed in the country.[5] However, this shift in the surgical method did not occur in Ireland.[23] Another explanation is a difference in the health care delivery system. While most hospitals are public in the Scandinavian countries, the majority of them are private in Japan and the United States,[35,39] thus the level of reimbursement may have played a role in treatment decision-making.[20,41] Furthermore, the percentage of private hospitals in Japan had been increasing during the study period and was 69% in 2017. This may partly explain the high and rising surgical rate in

this study. The results of our study suggest that the trend favoring nonsurgical treatment over surgical treatment for ATR may not be observed outside the Scandinavian countries. Therefore, more research is needed to clarify the worldwide trend in the management of ATR.

Patients aged ≥60 years accounted for 24% of the total patients with ATR. In addition, the median age of patients was 45 to 49 years for both men and women throughout the study period. This median age is older than that reported in previous studies, but the age of patients with ATR has increased over time, possibly because of the increasing aging population.[11] In more recent epidemiologic studies, the median age was similar to that reported in our study, ranging from 46 to 51 years after 2010.[9,15,32] Compared with younger patients, older patients tend to undergo more nonoperative treatments rather than surgical treatment.[9] Similarly, in this study, the proportion of surgery appeared to be lower in patients aged ≥60 years than in those aged 29 to 39 and 40 to 59 years. However, the optimal treatment for older patients remains unknown,[15] and further research is needed.

A strength of this study was that the NDB is a comprehensive medical database that includes all medical claims regardless of the type of hospital (public or private), type of treatment (surgical or nonsurgical), or treatment setting (inpatient or outpatient). Therefore, the results of this study represent the trend in the whole country. In contrast to our study, previous population-based studies have included only patients who were admitted to hospitals[21,22,28] or who underwent surgery.[22] Estimating the true incidence numbers and the nationwide trend in the treatment methods would be difficult from such data.

There are several limitations to this study. First, patients with multiple registry entries were scored as having only 1 rupture/surgery because of the inability to determine whether the second entry was the result of a new rupture in the contralateral AT or a complication (such as a rerupture) in the index AT. Furthermore, inconsistency in diagnosing acute or chronic ruptures among the treating physicians could have occurred. However, these issues in diagnostic coding are common in health care database surveys.[9,15,28] Second, as stated previously, injuries covered by automobile liability insurance and workers' compensation are not registered by the NDB. Third, we used a combination of both diagnostic and procedural codes to define ATR and surgical treatments. This definition has not been validated; however, administrative database research has often used nonvalidated diagnostic or procedural codes.[40] In combination, these limitations may have caused our study to underestimate the true incidence of ATR and surgery. Although the diagnosis of ATR is relatively straightforward, further studies are needed to validate the coding methodology for the identification of patients with ATR. Fourth, although we observed no significant change in the incidence of ATR, the 8-year span of this study may not have been sufficient to address the trend.

CONCLUSION

The incidence of ATR did not change between 2010 and 2017 according to the national health care database in Japan. Furthermore, the proportion of surgical treatments performed increased during this study period. The trend in the incidence and surgery observed in our study differed from that reported from the national registry data in the Scandinavian countries.

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APPENDIX

TABLE A1
Annual Incidence of ATR by Sex and Age Category[a]

Age Category, y	ATR per 100,000 People								
	2010	2011	2012	2013	2014	2015	2016	2017	*P*
Women									
20-39	8.3	8.5	8.4	8.1	8.4	9.1	8.8	8.6	.87
40-59	14.4	14.3	14.6	14	13.4	13.9	13.4	12.5	.67
≥60	4.5	4.8	5	4.6	4.6	4.8	4.8	4.9	.93
Overall	8.6	8.7	8.9	8.4	8.3	8.8	8.5	8.2	.91
Men									
20-39	19.3	19.5	21.1	22.7	22.9	23	23.4	22.9	.41
40-59	21.7	20.7	22.5	22.9	22.5	23.6	23.3	23.7	.63
≥60	11.5	11.7	12.5	12.5	12.5	13.1	12.5	12.8	.75
Overall	17.4	17.2	18.5	19	18.9	19.5	19.2	19.4	.63

[a]ATR, Achilles tendon rupture.

TABLE A2
Annual Proportion of ATR Treated Surgically by Sex and Age Category[a]

Age Category, y	ATR Treated Surgically, %								*P*
	2010	2011	2012	2013	2014	2015	2016	2017	
Women									
20-39	66	64	67	68	72	72	74	71	**.009**
40-59	65	69	68	67	71	71	70	70	.06
≥60	61	64	62	64	63	64	66	65	**.03**
Overall	65	67	66	66	69	69	70	69	**.004**
Men									
20-39	72	73	74	77	79	77	75	78	**.02**
40-59	69	69	70	72	73	74	73	73	**.003**
≥60	62	64	65	63	66	67	67	65	**.03**
Overall	68	69	70	72	74	73	72	73	**.006**

[a]Bolded *P* values indicate statistically significant differences over the study period (*P* < .05). ATR, Achilles tendon rupture.