Seasonal Variation in the Onset of Acute Calcific Tendinitis of Rotator Cuff

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Abstract

Background
Calcific tendinitis of the rotator cuff is a common disorder that causes acute onset of shoulder pain when spontaneous resorption of the calcification occurs. However, factors that trigger calcium resorption have not been clarified. The present study aimed to investigate the association between the onset of calcium resorption in calcific tendinitis and the season of onset.

Methods
We retrospectively reviewed 200 patients (female, 120; male, 80; mean age, 62.8 ± 14.2 years) diagnosed with acute calcific tendinitis between 2006 and 2018. The onset date of acute calcific tendinitis for each patient was collected from clinical notes. The incidence of acute calcific tendinitis in each season and month and the correlation between the incidence of acute calcific tendinitis and the mean monthly temperature or humidity levels were evaluated.

Results
The most common season of acute calcific tendinitis onset was summer (35.5%), followed by spring (24.5%), autumn (24.0%), and winter (16.0%) (P = 0.002). Monthly analyses showed the highest peak of onset was in July (15.5%) and the lowest peak was in February (3.0%) (P = 0.018). The incidence of acute calcific tendinitis had a weak association with mean monthly temperature ($R^2 = 0.074; P = 0.001$), but was not associated with mean monthly humidity levels ($R^2 = 0.024; P = 0.055$).

Conclusions
This study provides new information on seasonal variation of acute calcific tendinitis onset. The results of this study indicated that the onset of calcium resorption occurs most frequently in the summer in Japan; however, the reasons for seasonal variation remain unclear, and further studies will be needed.

Background
Calcific tendinitis of the rotator cuff is a common disorder, in which calcified deposits are formed in the rotator cuff, followed by spontaneous phagocytic resorption. ¹ ² Calcific tendinitis is generally classified into formative and resorative phases. ² Although the formative phase of calcific tendinitis is characterized by mild chronic pain or no symptom, when spontaneous resorption of the calcification occurs, patients present with acute onset of severe shoulder pain, making shoulder joint motion difficult. ¹ Thus, it is important to identify factors that induce calcium resorption in the rotator cuff. However, the etiology of calcific tendinitis remains unclear and factors triggering calcium resorption have not been well understood. In addition, the seasonality of calcific tendinitis has not been reported.

The present study aimed to investigate the association between the onset of calcium resorption in calcific tendinitis and the season of onset.

Methods
This study was approved by our hospital’s Independent Ethics Committee (No. R19-135).

Patient Selection
We performed a retrospective study that reviewed patients who were diagnosed with calcific tendinitis at one general hospital in Tokyo between January 2006 and December 2018. Our institution accepted outpatient visits without a referral letter or reservation during the same period. The diagnosis of calcific tendinitis was made from physical findings and plain radiograph images. In the resorptive phase of calcific tendinitis, symptoms of pain usually disappeared in 1–2 weeks after the onset. Therefore, our study included patients with limited active motion due to intense acute pain with a well-defined onset date within 2 weeks, in addition to the presence of calcific deposition in the rotator cuff on plain radiographs (Fig. 1), which was defined as acute calcific tendinitis. Conversely, even if patients present with calcific deposition on plain radiographs, those who experienced chronic pain or those with predominantly pain arc signs were considered to have symptoms during calcium formative phase and were excluded.

We identified 257 patients who met the inclusion criteria. Fifty-seven patients were excluded based on the exclusion criteria. Among the remaining 200 patients [mean age: 62.8 ± 14.2 years (range, 27–104 years)], 120 (60.0%) were female. The affected shoulder was the right in 122 patients (61.0%) and was the left shoulder in 78 patients (39.0%).

Outcome Measures

A single examiner obtained the onset date of acute calcific tendinitis from clinical notes. The date of each event was categorized into 4 seasons and 12 months. The seasons were categorized as every 3 months (the period from March to May was defined as spring, that from June to August was summer, that from September to November was autumn, and that from December to February was winter). The incidence of acute calcific tendinitis in each season and month was tabulated and comparatively evaluated.

We also collected the local climate data from the Japan Meteorological Agency and evaluated the association between the incidence of acute calcific tendinitis and mean monthly temperature or mean monthly humidity levels. Mean monthly temperature and mean monthly humidity levels between 2006 and 2018 in Tokyo are shown in Table 1.
Table 1
Mean monthly temperature and mean monthly humidity levels between 2006 and 2018 in Tokyo

| Month    | Mean monthly temperature (°C) | Mean monthly humidity levels (%) |
|----------|-------------------------------|---------------------------------|
| January  | 5.9 ± 0.8                      | 46.7 ± 5.3                      |
| February | 6.5 ± 0.9                      | 52.3 ± 4.2                      |
| March    | 10.0 ± 1.1                     | 54.5 ± 6.3                      |
| April    | 14.7 ± 1.1                     | 60.4 ± 5.8                      |
| May      | 19.7 ± 0.7                     | 64.2 ± 3.8                      |
| June     | 22.5 ± 0.7                     | 71.8 ± 4.5                      |
| July     | 26.6 ± 1.0                     | 74.2 ± 3.7                      |
| August   | 27.8 ± 1.1                     | 72.7 ± 4.9                      |
| September| 24.1 ± 1.1                     | 72.9 ± 6.9                      |
| October  | 19.0 ± 0.7                     | 68.2 ± 5.4                      |
| November | 13.4 ± 0.9                     | 62.3 ± 6.5                      |
| December | 8.5 ± 1.1                      | 53.8 ± 3.5                      |

Statistical analysis

All statistical analyses were conducted using the SPSS software program (Version 26.0, IBM Corp., Armonk, NY, USA). Goodness-of-fit tests were performed for season and month of onset of acute calcific tendinitis. Simple linear regression was used to test for the correlation between the incidence of acute calcific tendinitis and the mean monthly temperature or humidity levels. The threshold for significance was set at \( P < 0.05 \).

Results

The most common season of acute calcific tendinitis onset was summer (35.5%), followed by spring (24.5%), autumn (24.0%), and winter (16.0%) \( (P = 0.002) \). These distributions were observed in both females and males in the analysis with respect to sex; however, significant differences were only observed in females \( (P = 0.010) \) (Table 2). Monthly analyses showed the highest peak was in July (15.5%) and the lowest in February (3.0%) \( (P = 0.018) \) (Table 3). There was a weak association between mean monthly temperature and the incidence of acute calcific tendinitis \( (R^2 = 0.074; \ P = 0.001) \), but no significant association was found between mean monthly humidity levels and the incidence of acute calcific tendinitis \( (R^2 = 0.024; \ P = 0.055) \).
### Table 2
Seasonal distribution of the onset of acute calcific tendinitis

| Number of patients | Winter n (%) | Spring n (%) | Summer n (%) | Autumn n (%) | Goodness of fit |
|--------------------|--------------|--------------|--------------|--------------|-----------------|
| Total              | 200          | 32 (16.0)    | 49 (24.5)    | 71 (35.5)    | 15.4            |
|                    |              |              |              |              | 0.002           |
| Females            | 120          | 20 (16.6)    | 28 (23.3)    | 45 (37.5)    | 11.2            |
|                    |              |              |              |              | 0.010           |
| Males              | 80           | 12 (15.0)    | 21 (26.3)    | 26 (32.5)    | 5.1             |
|                    |              |              |              |              | 0.165           |

n: number

### Table 3
Monthly distribution of the onset of acute calcific tendinitis

| Month  | Number (%) out of 200 |
|--------|-----------------------|
| January| 13 (6.5%)             |
| February| 6 (3.0%)              |
| March | 16 (8.0%)             |
| April | 18 (9.0%)             |
| May | 15 (7.5%)             |
| June | 20 (10.0%)            |
| July | 31 (15.5%)            |
| August | 20 (10.0%)           |
| September | 16 (8.0%)         |
| October | 18 (9.0%)           |
| November | 14 (7.0%)          |
| December | 13 (6.5%)           |

\( P = 0.018, \) by goodness-of-fit test
In this study, we investigated the seasonality of acute calcific tendinitis onset in Japan. The results of our study indicated that the occurrence of acute calcific tendinitis exhibited a seasonal distribution characterized by a summer peak in July. Additionally, this study suggested that the mean monthly temperature can affect the onset of acute calcific tendinitis.

To date, seasonal variation of calcium resorption in calcific tendinitis has not been clarified. Regarding musculoskeletal pain, some previous studies have reported that cold or humid weather conditions negatively influence the symptoms of patients with chronic pain. However, our results do not agree with those of previous reports on musculoskeletal chronic pain. This discrepancy suggests that the mechanism of pain associated with the onset of calcium resorption differs from that of musculoskeletal pain. Conversely, acute gout attack, a type of microcrystalline arthritis, has also been reported to exhibit seasonality, with its onset being less frequent in the winter and more frequent in the spring to summer seasons. These results are similar to those of seasonal distributions in the present study. However, the incidence of acute gout attack has been reported to have no significant association with mean monthly temperature. Thus, changes in physical activity, serum uric acid/lipid/cortisol levels, diet, and alcohol consumption associated with seasons were suggested as triggering factors of acute gout attack.

Based on the results of this study, the mechanism behind seasonal variation of acute calcific tendinitis is unclear; however, several possible hypotheses can be raised. One hypothesis involves the regulation of phagocytic activity of immune cells by body temperature. Pathological findings in the resorptive phase of calcific tendinitis include macrophage and multi-nucleated giant cells surrounding broken-up calcium deposits, and phagocytosis of the calcification by these cells is suspected to cause the calcium resorption. Furthermore, diffuse of apatite crystals from calcification into the subacromial bursa causes acute severe pain. While the function of macrophages can be regulated by various factors, transient receptor potential melastatin 2 (TRPM2), a thermosensitive channel expressed in wide range of immunocytes including macrophages, has also been identified to regulate macrophages. TRPM2 contributes to enhancing the phagocytic activity of macrophages when body temperature is elevated. When the ambient temperature is elevated in the summer, the opportunity of increasing the skin temperature also increases, which may predispose the activation of phagocytosis in macrophages. This mechanisms could possibly explain the predominance of the onset of acute calcific tendinitis in the summer. Another hypothesis is that repetitive microtrauma owing to increased physical activity in the summer may affect the immune responses in the rotator cuff. However, further studies are needed to clarify the mechanism of the seasonal variation of acute resorption of calcific tendinitis.

This study has several limitations. First, because this is an observational study, it can be influenced by residual confounding owing to bias caused by factors not measured in this study. For example, the concurrence of rotator cuff and adhesive capsulitis can cause to trigger the onset of acute calcific tendinitis, but these factors were not considered in this study. Second, as this study was conducted in a general hospital in Tokyo and the sample population was small, this may have resulted in selection biases, and the ethnicity was limited to the Japanese population. Thus, the present results may not represent general population.

This study provides new information on seasonal variation of acute calcific tendinitis onset. The results of this study indicated that the onset of calcium resorption occurs most frequently in the summer in Japan; however, the reasons for seasonal variation remain unclear, and further studies will be needed.
Abbreviations

TRPM2: transient receptor potential melastatin 2

Declarations

Ethics approval and consent to participate:

This study was approved by the National Hospital Organization Tokyo Medical Center Independent Ethics Committee (No. R19-135). Due to the retrospective nature of the study, opt-out consent was performed for each patient on our hospital’s bulletin board and website. Opt-out consent relies on implicit consent, where willingness to participate is tacit or presumed, and can be retracted by active objection.

Consent for publication:

Not Applicable

Availability of data and materials:

Data that support the findings of this study are available from the corresponding author on reasonable request.

Competing interests:

The authors declare that they have no competing interests.

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The authors certify that they or their institutions did not receive any support (e.g. grants, funding, payment or other benefits) or a commitment or agreement to provide such benefits in connection with the research or preparation of this manuscript. We also received no funding for the design of the study; the collection, analysis, and interpretation of data and in writing the manuscript.

Authors’ contributions:

All authors contributed to the study conception and design. Study design was planned by RF and AY. Material preparation, data collection and analysis were performed by RF. The first draft of the manuscript was written by RF and NM. YK, MT, and HM contributed to previous versions of the manuscript. All authors read and approved the final manuscript.

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Figures
Figure 1

Plain radiographs of acute calcific tendinitis of the rotator cuff. (a) Plain radiography performed at the onset of acute calcific tendinitis shows calcium deposition in the rotator cuff in an 80-year-old woman. (b) After 3 weeks from the onset, calcium deposition has disappeared.