Comparison of Preferred Bite Sites between Mites and Ticks on Humans in Korea

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Abstract. Identification of mite and tick bite sites provides important clinical information. The predominant mite species in Korea associated with scrub typhus are *Leptotrombidium pallidum* and *Leptotrombidium scutellare*. The most abundant tick species is *Haemaphysalis longicornis*. To date, there have been no comparative studies on preferred bite sites between mites and ticks in humans. This study included a review of medical records and a field study. For mite bites, eschars were checked on 506 patients with scrub typhus, confirmed by indirect immunofluorescence assay or nested polymerase chain reaction on the 56-kDa type-specific antigen gene of *Orientia tsutsugamushi*. Tick bite sites were identified and marked on a diagram for 91 patients who experienced tick bites within the previous year through a field epidemiological investigation. The mite and tick bite sites in Koreans were compared. The most frequently observed mite bite sites were the anterior chest, including the axillae (29.1%) and the abdominal region, including the inguinal area (26.1%). Tick bite sites were most frequent on the lower extremities (33.0%), followed by the abdominal region, including the inguinal area (26.4%), and upper extremities (26.4%). The distribution was significantly different between mite and tick bite sites (*P* < 0.001). There was a statistically significant difference in the mite bite (*P* = 0.0001), but not tick bite sites (*P* = 0.985), between men and women. This is the first report on the differences between tick and mite bite sites, and may help clinicians reach a rapid diagnosis of mite- or tick-borne infection.

INTRODUCTION

Acaridans are broadly distributed worldwide and have different habits; most live freely but some are parasitic. There are approximately 500,000 acaridan species that are divided into mites and ticks depending on morphological characteristics.† Acaridans are vectors of diseases, including viral, rickettsial, and bacterial diseases. Mites are vectors for diseases such as scrub typhus and rickettsialpox. Ticks can transmit the agents of diseases such as Lyme disease, human ehrlichiosis, anaplasmosis, babesiosis, relapsing fever, Rocky Mountain spotted fever, Colorado tick fever, tularemia, Q fever, and tick anaplasmosis, babesiosis, relapsing fever, Rocky Mountain agents of diseases such as Lyme disease, human ehrlichiosis, anaplasmosis, babesiosis, relapsing fever, Rocky Mountain

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be caused by *H. longicornis*, the SFTS virus was identified not only in *H. longicornis* but also in *Amblyomma* and *Ixodes*.17,20 Tick bite sites are highly important clinical clues to the diagnosis of tick-borne infectious diseases.

Although chigger-related eschars can be found anywhere on the human body,11,12 chiggers reportedly prefer folded and damp skin areas such as in the underpants and axillary regions.21,22 However, few studies have investigated the preferred bite sites of mites (eschars) or ticks,3 and to the best of our knowledge, a comparative study of mite bite and tick bite sites has not been conducted.

The present study aimed to comparatively analyze mite bite and tick bite sites in humans in South Korea by investigating eschar locations in patients with scrub typhus and tick bite sites from a field epidemiological investigation.

**MATERIALS AND METHODS**

For mite bites, patients ≥18 years old, with an acute fever caused by scrub typhus, and visited Chosun University Hospital (Gwangju), St. Vincent’s Hospital (Suwon), Yeungnam University Hospital (Daegu), or Eulji University Hospital (Daejeon) in South Korea between September 2004 and December 2008 were eligible for the study. When a patient with suspected scrub typhus visits any of these hospitals, they undergo a complete physical examination. Once eschars are found, the eschar locations are marked on a diagram in a prospective epidemiologic report and then recorded in the medical records. We collected and stored blood from patients and used buffy coats of the patient blood samples for PCR assay. Patients were confirmed with scrub typhus by 56-kDa gene targeting nested PCR and indirect immunofluorescence assay (IFA).

For tick bites, patients were selected based on a survey of tick contact conducted from July 2014 to December 2014 during a field study in Chonnam Province, South Korea. In that questionnaire, we asked the survey recipients to draw the tick bite site by their own on a human figure diagram as shown in Figure 1. We did not identify tick or mite species in this study.

This study was conducted with the approval of the Institutional Review Board (IRB) of Chosun University Hospital (IRB 2014-04-007). Informed consent was obtained from all participants.

Patients with ≥2 eschars or bite sites were excluded. Mite and tick bite sites on the human body were divided into head and neck, anterior chest including the axillary region, back, and tick bite sites on the human body were divided into head and neck, anterior chest including the axillary region, back, and tick bite sites on the human body.11,12 Chiggers reportedly prefer folded and damp skin areas such as in the underpants and axillary regions.21,22 However, few studies have investigated the preferred bite sites of mites (eschars) or ticks,3 and to the best of our knowledge, a comparative study of mite bite and tick bite sites has not been conducted.

The present study aimed to comparatively analyze mite bite and tick bite sites in humans in South Korea by investigating eschar locations in patients with scrub typhus and tick bite sites from a field epidemiological investigation.

**RESULTS**

Of the 780 eligible patients with mite bites, 605 patients were included based on the medical records. Of the 510 patients with confirmed scrub typhus by PCR and IFA, four patients with ≥2 eschars were excluded, resulting in 506 patients with mite bites in the final sample.

Of the 111 patients who reported experiencing tick bites during the previous year in the field survey, 20 patients with ≥2 bite sites were excluded, resulting in 91 patients with tick bites in the final sample.

Mite bite sites were most frequently observed on the anterior chest, including the axillary region (147 patients, 29.1%), and tick bite sites were most frequently observed on the lower extremities (30 patients, 33.0%) (Table 1). There was a statistically significant difference between mite and tick bite sites (*P* < 0.001).

The highest frequency of mite bites in men (*N* = 188) was on the abdominal region, including the inguinal area (53, 28.2%), and the highest frequency of mite bite sites in women (*N* = 318) was on the anterior chest, including the axillary region (109, 34.3%) (Table 2). The difference in the distribution of the mite bite sites between genders was statistically significant (*P* = 0.001).

The highest frequency of tick bites was on the lower extremities for both genders (nine male patients, 34.6%; 21 female patients, 32.3%; *P* = 0.985) (Table 2).

The difference between mite bite and tick bite sites was not significant in men (*P* = 0.234), but was significant in women (*P* < 0.001).

Overall, eschars corresponding to mite bite sites were usually observed in joint regions where the skin is folded (Figure 1), specifically in the axillary region, inguinal area, and popliteal fossa. In addition, they were frequently observed in the external genitalia regions, including the umbilical region. Although eschars were frequently observed in the breast regions and on the back in women, they were rarely found on the breasts or backs of men. On the lower extremities, eschars were mostly found in the knee areas, specifically in the popliteal fossa rather than on the anterior knees.

**DISCUSSION**

Ticks tend to prefer specific hosts such as humans and wild and domestic animals depending on the species and lifecycle stage. The factors affecting the spread of tick-borne infectious diseases include the tick species and lifecycle stage, duration of adherence to the host, site of adherence, location of human activity, and geographical and weather conditions.17,26 Scrub typhus can be diagnosed using an antibody test or PCR, and treatment usually begins based on the identification of eschars, even before antibody test results are available for most patients. Therefore, early detection is critical for
timely treatment. Eschars, which correspond to the bite sites by Trombiculid species, are one of the most critical findings for diagnosis. The reported differences in the rate of eschar detection are substantial depending on investigators and vary from 19% to 94% among scrub typhus patients.

In Korea, most studies have reported that scrub typhus is more frequently found in women than in men, and the present study also identified a higher prevalence in women. This difference was associated with a higher proportion of rural women and was also affected by work characteristics. Because men worked with tools while standing in rice paddies, whereas women worked with their bare hands while squatting in the fields, women had a greater exposure to acaridans than men.
In this study, mite bite sites were usually located at damp areas of the body, whereas tick bite sites were not limited to specific areas, findings consistent with the results reported by Chae and others.30

In the present study, eschars were most frequently observed where the skin was folded around joints, particularly in the axillary region, inguinal area, and popliteal fossa, as well as in regions hidden by underpants, such as the inguinal area and external genitalia, including the proximal umbilical region. Regarding the knee area, eschars were observed more often at the popliteal fossa than at the anterior knee, especially at the sides of the popliteal fossa where the skin begins to fold rather than in the middle of the popliteal fossa, where the skin is completely folded when squatting. Similarly, Kim and others reported that eschars from mite bites are frequently found in regions of folded and damp skin such as inside the underpants, the axillary region, and the popliteal fossa; eschars were most frequently found within a 30-cm area below the umbilicus in men and women and the anterior chest, including the axillary area over the umbilicus, in women. In the present study, women had eschars around the breasts and on the back, whereas men rarely had eschars in these areas. Chiggers are unable to fly; instead, they climb the human body from regions hidden by underpants, such as the inguinal area and, areas of high pressure because of a belt or a brassiere that results in warm and damp skin)31,32 Therefore, the observed gender-based difference might be due to the damp areas caused by brassiere straps on the back in women and the need to squat to urinate in the bushes; mites might access the neck in contact with tall grass, resulting in bites on the back in women. As such, these characteristic differences in eschar formation by gender seem to be due to pressure and moisture caused by brassieries, tight underwear, and knee bending.

Ticks have different preferences for host type and body region depending on the life cycle stage. For example, larvae and nymph instars reportedly prefer small animals over large animals and immature 0- to 9-year-old children over adults. Also, instars tend to prefer thinner skin such as that of the axillary regions, eyelids, popliteal fossa, and ears.17,26,33 The most common site of attachment varies between individual species, with Ixodes preferring the trunk, Amblyomma preferring the lower extremities, and Dermacentor preferring the head, neck, or upper trunk.34 In another study, adults of Haemaphysalis spp., Dermacentor spp., and Rhipicephalus spp. preferred young adults, and in particular, Dermacentor spp. preferred hairy areas in animals five times more than other areas, demonstrating the differences in preferred areas depending on species.17

In addition, more mite bite sites were on the upper body including the anterior chest and axillary region, whereas more tick bite sites were observed on the lower extremities in the present study (Table 1). Chiggers prefer thinner skin, including that of the axillary region, eyelids, popliteal fossa, and ears, whereas ticks in the adult stage prefer the extremities; most ticks that bite humans are in the nymph or adult stage.

The present study presented accurate data by analyzing eschars, which are mite bite sites, on patients who had confirmed scrub typhus using IFA and nested PCR on the 56-kDa gene. However, the study was limited by the retrospective nature of the tick bite data, which was collected via a field study using a questionnaire. Survey recipients marked sites of tick bites that they had received within the past year on diagrams based on recall; therefore, the accuracy of the information could not be assessed. In addition, the tick species could not be confirmed. Further systematic studies should be conducted to accurately determine bite site preferences for ticks and mites according to species.

In conclusion, this is the first study showing that eschars, which are mite bite sites, were most frequently identified on the anterior chest, including the axillary region, and abdominal region, including the inguinal area, whereas most tick bite sites were observed on the lower extremities. Furthermore, the most frequent mite bite sites in men were the abdominal region, including the inguinal area, and lower extremities, whereas in women they were most frequently observed on

### Table 1
Comparison of mite bite and tick bite sites

<table>
<thead>
<tr>
<th>Site</th>
<th>Mite bite n (%)</th>
<th>Tick bite n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head, face, and neck</td>
<td>31 (6.1)</td>
<td>3 (3.3)</td>
</tr>
<tr>
<td>Front chest above umbilicus (including the axilla)</td>
<td>147 (29.1)</td>
<td>7 (7.7)</td>
</tr>
<tr>
<td>Back</td>
<td>48 (9.5)</td>
<td>3 (3.3)</td>
</tr>
<tr>
<td>Front and rear areas within 30 cm below the umbilicus (including the perineal, inguinal, and buttock areas)</td>
<td>132 (26.1)</td>
<td>24 (26.4)</td>
</tr>
<tr>
<td>Upper extremities</td>
<td>56 (11.1)</td>
<td>24 (26.4)</td>
</tr>
<tr>
<td>Lower extremities</td>
<td>92 (18.2)</td>
<td>30 (33.0)</td>
</tr>
<tr>
<td>Total</td>
<td>506 (100)</td>
<td>91 (100)</td>
</tr>
</tbody>
</table>

*Student’s t-tests were performed to compare the mite bite and tick bite sites at each body site. There was a statistically significant difference between mite and tick bite sites (P < 0.001).*

### Table 2
Comparison of mite bite sites and tick bite sites by gender

<table>
<thead>
<tr>
<th>Bite sites</th>
<th>Mite bite (N = 506) n (%)</th>
<th>Tick bite (N = 91) n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men (N = 188)</td>
<td>Women (N = 318)</td>
<td>Men (N = 26)</td>
</tr>
<tr>
<td>Head, face, and neck</td>
<td>9 (4.8)</td>
<td>22 (6.9)</td>
</tr>
<tr>
<td>Front chest above umbilicus (including the axilla)</td>
<td>38 (20.2)</td>
<td>109 (34.3)</td>
</tr>
<tr>
<td>Back</td>
<td>15 (8.0)</td>
<td>33 (10.4)</td>
</tr>
<tr>
<td>Front and rear areas within 30 cm below the umbilicus (including the perineal, inguinal, and buttock areas)</td>
<td>53 (28.2)</td>
<td>79 (24.8)</td>
</tr>
<tr>
<td>Upper extremities</td>
<td>28 (14.9)</td>
<td>28 (8.8)</td>
</tr>
<tr>
<td>Lower extremities</td>
<td>45 (23.9)</td>
<td>47 (14.8)</td>
</tr>
</tbody>
</table>

*Student’s t-tests were performed to compare the mite bite and tick bite sites by gender.

P value: 0.001* 0.985
the chest, including the axillary region, and abdominal region, including the inguinal area, showing a significant difference by gender. However, tick bite sites were not different between men and women. The present study should help establish a rapid diagnosis of mite- or tick-borne infections through improved recognition of mite and tick prone areas by physicians and reduce complications caused by a delay in diagnosis.

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