Evaluation of Five Popular Methods for Tick Removal

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ABSTRACT. Five methods commonly advocated for tick removal from a human or domestic animal were evaluated. The application of petroleum jelly, fingernail polish, 70% isopropyl alcohol, or a hot kitchen match failed to induce detachment of adult American dog ticks (*Dermacentor variabilis* Say) attached for either 12 to 15 hours or three to four days. Use of forceps or protected fingers enabled satisfactory removal of 29 adult American dog ticks without leaving the mouthparts or attachment cement in the host skin. Four different methods were used to pull lone star ticks [*Amblyomma americanum* (L)] off the host using forceps (twisting, pulling steadily or jerking straight up, or pulling parallel with the skin). None of the mouthparts broke off, but, contrary to the American dog tick, the cement remained in the skin for all 22 of the Lone Star ticks. It is recommended that the tick be grasped as close to the skin as possible with curved forceps; if these are not available, use tweezers or protected fingers. Pull straight up with steady even pressure. If cement or mouthparts remain, then extract if that is practical. Disinfect bite site before and after tick removal. *Pediatrics* 1985;75:997–1002; *tick removal, tick mouthparts, dog tick, Dermacentor variabilis, ixodid tick.*

Worldwide, ticks are second only to mosquitoes as arthropod vectors of human diseases and exceed all arthropods in the variety and number of disease organisms they may transmit to domestic animals.[1] Within certain geographic areas of the United States, Rocky Mountain spotted fever, Colorado tick fever, tularemia, and, more recently, babesiosis[2] and Lyme disease [3] are transmitted by ticks. Each has a different causal agent, *Rickettsia*, virus, bacterium, *Protozoa*, and spirochete, respectively. In addition, the saliva of certain ticks contains a neurotoxin that may be secreted after several days of feeding, causing a flaccid ascending paralysis.[2] Children are likely to encounter these acarines (ticks and mites) because of their frequent contact with pets and tick habitats. There are two families of ticks that bite man: soft (argasid) ticks and hard (ixodid) ticks. The hard or ixodid ticks are, in general, of greatest concern because they are more frequently encountered than argasids, are difficult to remove, and are more likely to transmit disease to man.

It is important that a tick be removed from the host as soon as possible after it is discovered to reduce the chance of infection by disease organisms or to interrupt secretion of paralytic toxin. The lengthy feeding period (several days to weeks) is an important factor in the transmission of disease by ticks. During this time, disease organisms may multiply, undergo development, or become "reactivated"[2,4] before being secreted with the tick's saliva. Proper removal of the tick is just as important in reducing the chance of infection as timely removal. Three recent case reports of Rocky Mountain spotted fever in Ohio indicate that individuals may have contracted the disease through careless handling of infected ticks rather than by being bitten. Twisting or jerking the tick in an effort to remove it may break off the mouthparts in the skin. Two consequences that may result from breaking the mouthparts are: (1) foreign material left in the skin may produce a chronic site of irritation lasting weeks or months and may induce a secondary infection from persistent scratching, and (2) tick body fluids that escape may contain infectious organisms, and these could enter a break in the skin of the host or person removing the tick.

There are several traditional or "folk" methods recommended for inducing a tick to "back out" of the skin. Most are based on the fear that if a tick is pulled off, the "head" (mouthparts) will remain in the skin. The purpose of this investigation was

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to evaluate five methods commonly advocated for tick removal from an individual or domestic animal: (1) petroleum jelly, (2) fingernail polish, (3) 70% isopropyl alcohol, (4) hot kitchen match, and (5) forcible removal with protected fingers or forceps.

EXPERIMENTAL METHODS AND OBSERVATIONS

The American dog tick *Dermacentor variabilis* Say (Fig 1), and the lone star tick *Amblyomma americanum* (L) were chosen for these experiments. Adult *D variabilis*, free of spotted fever group *Rickettsia*, were selected from samples sent for testing to the Ohio Department of Health Vector Borne Disease Unit. Lone-star females were selected from a colony maintained at the Acarology Laboratory.

Three compartments made from orthopedic stockinette (30-cm long, 10-cm wide) were secured to the back of a female Dorset sheep using a water-base contact cement (Weldwood Plus 10, Robert Consolidated Industry, City of Industry, CA). The fleece in each compartment had been cut close to the skin surface, and the area was washed with soap and water. Ticks were placed in each compartment, and the open end was tied to prevent escape but allow easy access.

Dog Tick Removal After Three to Four Days of Attachment

Two different groups of dog ticks were subjected to five commonly suggested methods of tick removal. The first group of 29 ticks had been attached to the host for 72 to 96 hours. The methods used were as follows: (1) petroleum jelly was applied in a generous amount to the dorsum and venter of ten female ticks, making certain that the spiracles (respiratory openings) were covered; (2) four female ticks received similar treatment but with clear fingernail polish; (3) four female ticks had 70% isopropyl alcohol applied to the dorsum and venter with a cotton swab; and (4) a wooden kitchen match was struck, allowed to burn until red hot, then

TABLE. Recommended Procedure for Tick Removal

1. BLUNT CURVED FORCEPS or tweezers should be used. If fingers are used, shield them with a tissue, paper towel, or rubber gloves.
2. GRASP the tick as close to the skin surface as possible and pull upward with steady even pressure. DO NOT TWIST OR JERK the tick as this may cause the mouthparts to break off leaving the hypostome, and possibly the chelicerae (Figs 2 and 3) along with the cement collar.
3. *Take care not to squeeze, crush or puncture the body* of the tick as its fluids (saliva, hemolymph, gut contents) may contain infective agents.
4. DO NOT HANDLE THE TICK WITH BARE HANDS, as infectious agents may enter via mucous membranes or breaks in the skin. This precaution is particularly directed to individuals who "detick" domestic animals using unprotected fingers. Children should not be permitted to do this procedure.
5. After removing the tick, thoroughly disinfect the bite site and wash hands with soap and water.
6. Ticks can be safely disposed of by placing them in a container of alcohol or flushing them down the toilet.

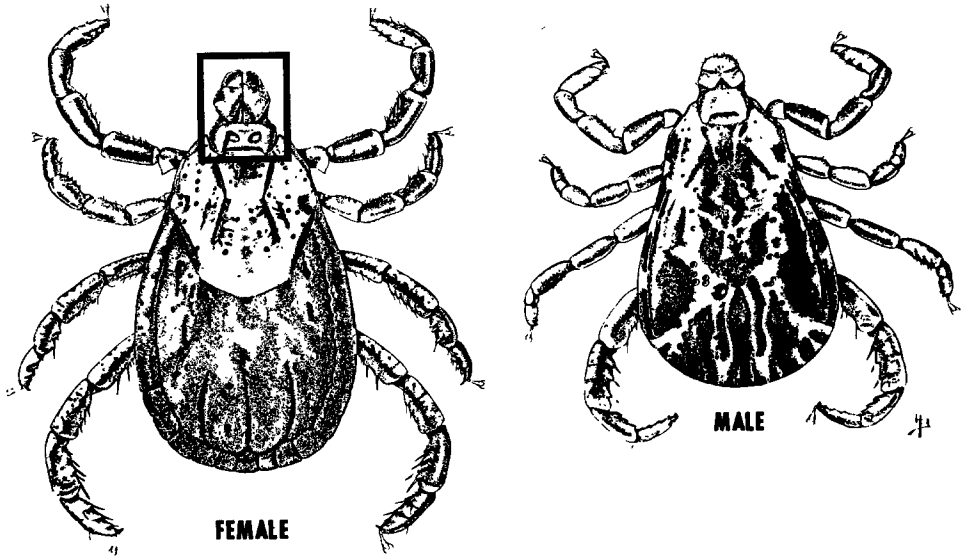

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Fig 1. Dorsal view of unfed female and male American dog ticks *Dermacentor variabilis*. Dorsum of male is hard, preventing distention from feeding. Posterior two thirds of female expand so it can increase more than 100 times in weight during seven to 14-day feeding period. Box shows area photographed in Figs 2 and 3.This is also area in which to grasp the tick for removal.

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blown out, and immediately held to the dorsum of the tick for 5 to 10 seconds. Four female ticks were treated in this manner with one receiving the treatment twice. These techniques were called "passive" because no mechanical force was used to dislodge the tick. The remaining ticks were removed mechanically with forceps or protected fingers as described in the Table. The objective was to see whether the ticks would back out of the skin within a two-hour period. None of the passive techniques induced self-detachment within the allotted time.

Twenty-nine ticks that had been attached 72 to 96 hours were forcibly removed: 24 with use of forceps and five with use of protected fingers. All were removed without breaking the mouthparts, and the cement collar (Fig 2, inset) was extracted as well. This cement is a tough material that looks somewhat like skin surrounding the mouthparts.

Dog Tick Removal After 12 to 15 Hours of Attachment

Ticks that have been on the host for a longer time may be more firmly attached due to the secretion of additional attachment cement (see Fig 2, inset).[1] For this reason the second series of tests applied the same passive methods to removal of 16 ticks that had been attached for a shorter time (12 to 15 hours). Passive methods were applied to each

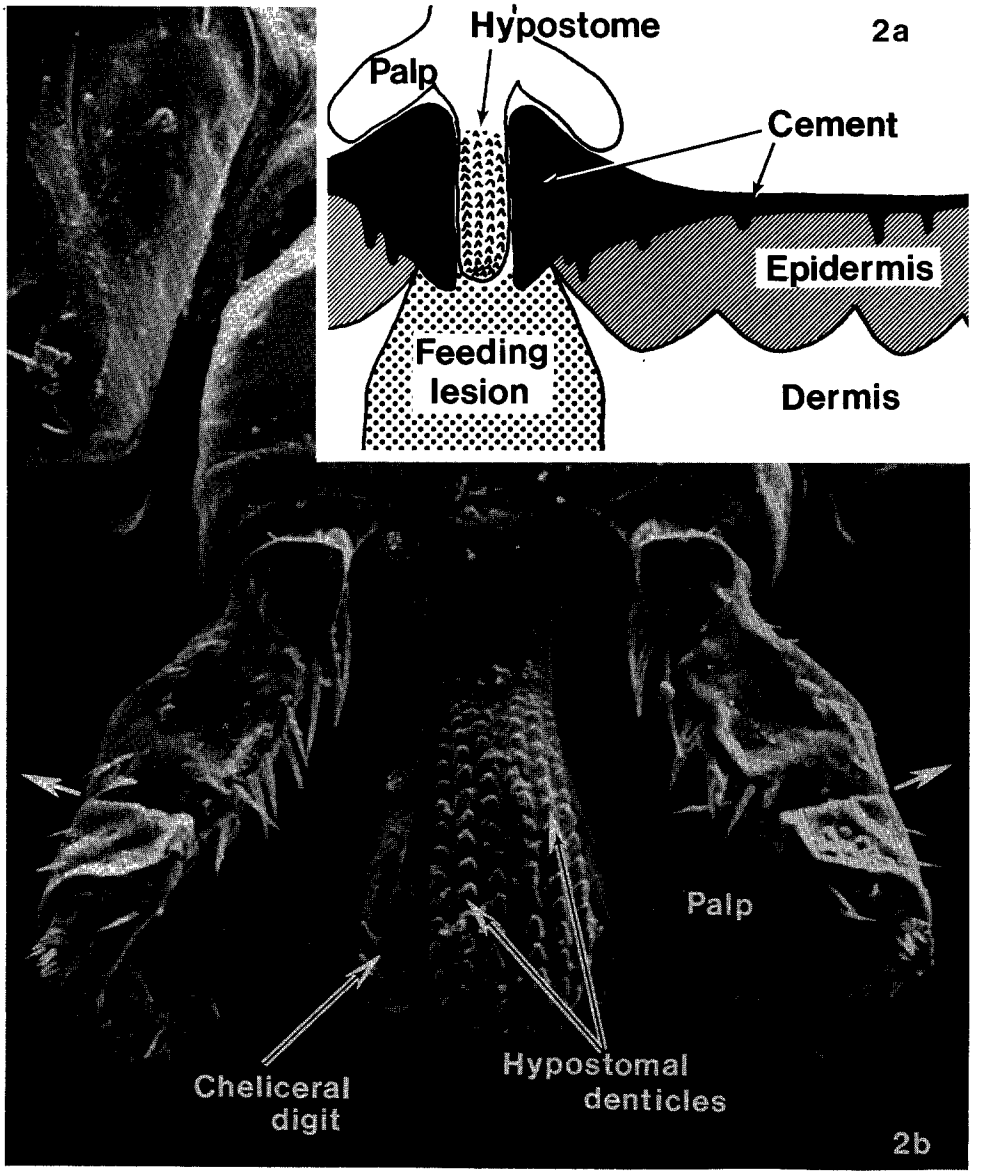

Fig 2. Ventral view of female American dog tick mouthparts. Hypostomal denticles help secure mouthparts in cement (×33). Inset, attachment in skin is facilitated by retrorse hypostomal denticles embedded in cement secreted by salivary glands. Palps do not enter nor are they cemented to skin. (Redrawn from Moorhouse.[5])

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of four ticks, and again none induced detachment within 24 hours after application. Forcible removal with forceps again removed the ticks intact with the cement still firmly attached to the mouthparts of the remaining four ticks plus the other 16 experimental specimens.

Mechanical Removal of Lone Star Tick

Four strategies were used to determine whether the method of pulling the tick off was critical relative to leaving the cement or mouthparts in the skin. Twenty-two female ticks that had been attached for three days were mechanically removed using forceps to grasp the tick as close to the skin as possible. Five ticks were removed by pulling straight up with steady even pressure, seven by pulling straight up with a quick motion, five were twisted clockwise (two to three revolutions), and five were removed by pulling the tick parallel with the skin using a steady even pressure (ventral aspect of the tick up).

In contrast to the results with the American dog tick in which the cement stayed on the mouthparts, the cement remained in the skin for all 22 lone stars ticks. Although they were damaged, none of the mouthparts broke off when turned clockwise.

DISCUSSION

Ixodid ticks are difficult to remove for several reasons. Most important, they cement the mouthparts into the skin, and the mouthparts are equipped with specialized structures for holding them in the cement (Figs 2 and 3). The hourglass shape of the hypostome may also help to anchor the mouthparts in the cement (Fig 2), as may the lateral extension of the cheliceral digits (Fig 3). Penetration of the skin is accomplished by the thrusting of cheliceral digits into the epidermis with subsequent lateral claw-like motions (Fig 3). Cement is secreted by the salivary glands and this latex-like material soon hardens into a tough collar surrounding the mouthparts (Fig 2, inset). Six rows of ventral hypostomal denticles (large retrorse teeth, Fig 2) and dorsal cheliceral sheath denticles (small retrorse teeth, Fig 3) are embedded in the cement to secure the adult tick in place for the long feeding interval (seven to 14 days). It has been hypothesized that in addition to anchoring the mouthparts, the cement buffers them from the skin,[1] and it may function as a gasket to prevent the leakage of fluid from the feeding lesion. The presence of the cement collar may also be the reason most individuals do not detect the tick until it becomes distended with blood during the final day of feeding. For some individuals, however, an irritation or itchy sensation may commence while the tick is attached (personal observation).

The American dog tick mouthparts and cement protrude into the epidermis with cement extending between cells of the stratum granulosum (Fig 2, inset). Based on animal studies, the bite of this tick is characterized by a thickening of the malpighian layer due to an increase in the cell number and an increase in cell volume.[5] When the tick detaches, the cement remains in the skin. This site may itch or become irritated for several weeks to several months.

Mechanical removal of the American dog tick usually extracts the cement collar and the mouthparts. This is desirable, for when left in the skin, there is a greater potential for subsequent irritation and secondary infection. In contrast, the cement was not extracted with the mouthparts of lone star ticks. It is obvious that species differences affect the outcome of forcible tick removal. There are anatomic and physiologic differences between sheep and human skin; however, based on my personal experience, the cement is usually extracted for the American dog tick but not the lone star adults using the mechanical removal technique for human subjects. Specifically, the difficulty of removal depends on: (1) the length and shape of the mouthparts; (2) the number, size, and shape of retrorse denticles; (3) the amount of cement secreted (some ticks of the genus *Ixodes* do not secrete cement); (4) the size of the tick, which is determined by its developmental stage (larval, nymphal, or adult), and the length of time it has been feeding; and 5) how the host reacts to the tick attachment and feeding. If the mouthparts break off, it may be desirable to extract them and the cement to avoid subsequent irritation. If no cement of "flesh-like" material is attached to the mouthparts, then it (cement) is still in the skin.

Several reports on tick removal appear in the literature. Use of forceps or protected fingers to grasp the tick close to the skin and the application of steady retracting pressure are commonly cited,[6,7] A slight variation of this technique is to gently lift the tick so the venter is up, then with the application of mild tension, pull parallel with the skin until the tick detaches.[7] I have been told and have read in a reputable first aid manual that the tick should be twisted counter-clockwise to remove it. Neither of these methods nor the other ones I tried seemed to make any difference when removing lone star ticks.

It is not unusual for the tick to continue to salivate for several minutes after removal (personal observation), and if it is infected, the possibility of accidental inoculation with a disease agent is increased with careless handling of the tick. The

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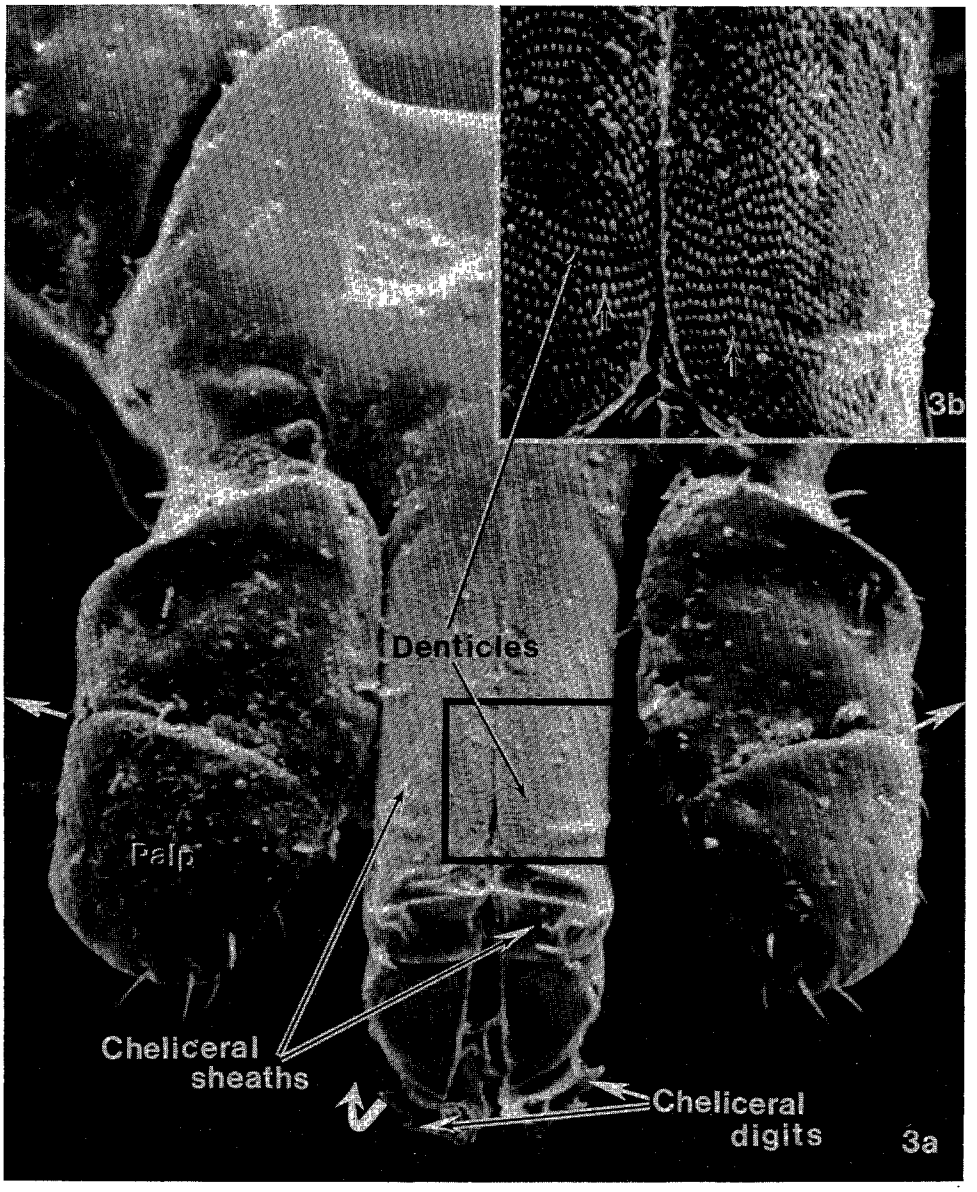

Fig 3. Dorsal view of female American dog tick mouthparts (×33). Chelicerae are extended as if thrusting into the skin (compare 2). Digits articulate laterally as chelicerae retract to rip skin. Flexible cheliceral sheaths (note wrinkles) contain many small denticles (inset, arrows) that may help anchor mouthparts in cement.

longevity of the microorganisms outside the tick then becomes a critical factor in the degree of risk involved.

It was not surprising that the petroleum jelly, alcohol, or fingernail polish failed to induce detachment. The petroleum jelly has been cited as being "effective" because it appears to stop respiratory gas exchange, thus inducing ticks to loosen their hold.[8] Probably the same rationale is used for fingernail polish, although the volatile components in it could be incriminated as inducers of detachment. Occluding the tick's air supply, even for several hours, would not be expected to affect it because of its slow respiratory rate. An unfed adult tick may breathe a few times per hour at rest and only about 15 times per hour when active.[9] Ticks coated with the polish were unable to move once it had hardened, and this may actually have impeded self-detachment by the tick. The isopropyl alcohol helps to disinfect the bite, but this would seem to be the only benefit of its application. The hot match (or other hot objects) is a frequently mentioned method for inducing tick detachment. This procedure is not recommended for several reasons. First, the risk of burns, particularly to the uncooperative child or pet, is quite high. Second, a hot object could cause the tick to burst and result in exposure to infected body fluids of the tick. Third, this method did not

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effect detachment. Finally, hot objects may induce the tick to salivate or regurgitate infected fluids into the wound because heat in the form of infrared radiation will stimulate partially or fully fed ticks to salivate.[10]

Current research is directed toward the use of compounds that stimulate the tick to detach. These include a group of acaricides called formamidines (and related compounds) which induce hyperactivity and detachment within a few minutes.[11] Also, a considerable amount of work is being done to exploit the use of pheromones for the removal and control of ticks.[1] Male ticks will detach to search for a feeding female when sex pheromone (2, 6-dichlorophenol) is detected. A potential problem with all these passive techniques is that the cement remains in the skin after the ticks back out.

Based on these results, it is suggested that the mechanical removal technique be used for all ticks unless more research on other species and developmental stages of ticks dictates otherwise. Concerning the method of mechanical removal, it is likely that where one grasps the tick (mouthparts close to the skin *v* the general body of the tick) is more crucial than how the tick is pulled off (twisting, jerking, etc). By grasping the mouthpart, they are stabilized and less likely to be broken. Further experimentation is required to document this theory.

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