Density of Toruli Tactiles in the Goat (Japanese Saanen)

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Summary: Toruli Tactiles (TT) were clearly observed to be stained with methylene blue solution, and the density of distribution of TT on the body surface was measured in the goat. TT in the goat were present on the hairy skin as papilla-like structure of about 200 to 300 μm in plane-diameter. A high density of TT on the body surface occurred in the areas from the lateral portion of the arm to forearm, and from the thigh to leg. On the other hand, areas of low density of TT were present in the facial-cranial region except for the buccal-masseteric area, cranial-breast, perineum (male), axilla, inguen, carpus-metacarpus, and tarsus-metatarsus. TT were rarely observed in the ears, on the nose, around the mouth, perianal parts, palms and soles.

Toruli Tactiles (TT) were first described by Pinkus (1902) in the human skin as Haarscheiben, and have also been referred to by other names (epidermal papillae by Lovell and Getty, 1957; touch corpuscles by Iggo, 1963 and Iggo and Muir, 1969; touch spots by English, 1977; tactile elevations by Evans and Christensen, 1979 and Dyce *et al.*, 1987). Merkel cell-neurite complex was found to be present at the basal layer of the epidermis in the TT (Iggo, 1963; Iggo and Muir, 1969; Smith, 1967, 1970, 1977; Wakuri and Narita, 1986). Based on electrophysiological studies, they have been demonstrated to be slow adapting touch receptors (Iggo, 1963; Iggo and Muir, 1969).

The structure and distribution of TT have been described by Kamide (1955) in human beings, Smith (1967) in the rat, mouse, guinea pig, rabbit and cat, Iggo and Muir (1969) in the cat, Kasprzak *et al.*, (1970) in the kitten, Kamata (1983) in the mouse, and Wakuri *et al.*, (1987, 1988) in the dog and Japanese monkey. The TT of a ruminant were examined in a histological study by Mann (1965). However, NAV-NH (International Committee, 1983) and NAVJ (1987) gave descriptions of TT in only the Carnivora. In the present study, TT were readily detected by staining with methylene blue solution, and were measured in detail for their density of distribution on the body surface of the goat.

Materials and Methods

Two male goats (specimen No. 1 and specimen No.

3) and a female goat (specimen No. 2) (Japanese Saanen) were used. They were anesthetized with xylazine and perfused with Ringer's solution. They were then injected with 0.1% ~ 0.15% methylene blue solution at 37°C through the common carotid artery (Sano, 1985; Wakuri *et al.*, 1987). About one hour later, they were injected with 1% ammonium picrate and 5% ammonium molybdate so as not to dissolve the dye of the methylene blue solution. A further 12 hours later, they were fixed in 10% formalin. The hair was clipped and removed by shaving. TT in the skin were observed by loupes and marked with white lacquer. The marked TT were measured for their density of distribution (actual number per 2 cm square) in different parts of the body surface.

Results and Discussion

On staining with methylene blue solution, TT were clearly visible on the body surface of the goat (Fig. 1). The terminal plate of nerves in the basal layer of the epidermis of TT was stained with methylene blue solution (Kamide, 1955; Iggo, 1963; Iggo and Muir, 1969). TT were observed in most areas of the hairy skin (Fig. 2). The TT projected out from the hairy skin as papilla-like structures about 200 to 300 μm in diameter. The diameter of the TT in the goat was thus similar to that in the sheep (Mann, 1965).

Data for the quantitative distribution of TT per 2 cm square of the body surface are given in Table 1. Specimen No. 1 (male) and specimen No. 2 (female)

Table 1. Quantitative distribution of Toruli Tactiles on the body surface of the goat

Specimen No.		No. 1	No. 2	No. 3
Areas examined				
Cranial region	A1. frontal-temporal	5.2/4.2	6.4/9.4	4.0/4.4
	A2. parieto-occipital	5.6	9.8	3.4
	A3. buccal-masseteric	8.6/11.8	20.4/18.5	6.6/5.8
Cervical region	B1. nape	7.4/4.8	8.2/6.0	4.8/6.0
	B2. lateral of neck	8.6/8.0	11.0/9.8	5.4/5.4
	B3. ventral of neck	6.0/5.2	9.2/8.6	2.5/5.6
Thoracic region	C1. scapular	8.8/9.8	9.2/9.8	8.4/7.2
	C2. cranial breast	4.0/3.6	5.4/4.4	3.8/5.6
	C3. costal	9.0/12.2	7.0/9.4	6.4/6.8
	C4. costal cartilage	9.0/9.0	6.4/9.8	5.4/4.6
	C5. breast-xiphoid	8.4/8.8	7.0/6.0	3.2/4.2
Abdominal region	D1. xiphoid	13.4/12.8	7.4/8.0	6.4/4.6
	D2. lower costal	9.0/11.2	7.0/9.6	4.4/6.2
	D3. lateral abdomen	12.0/12.6	7.4/8.6	5.4/2.6
	D4. paralumbar	11.0/9.0	9.4/9.6	5.0/7.4
	D5. umbilical	10.6/10.2	8.2/10.4	8.0/7.4
	D6. pubic	8.8/8.8	7.2/7.6	10.0/7.2
Dorsal region	E1. interscapular-back	5.0/4.8	8.0/8.8	4.8/5.8
	E2. lumbar	7.6/8.0	7.2/9.8	6.0/7.4
Pelvic region	F1. scapal	7.0/7.4	12.2/15.5	4.8/7.2
	F2. gluteal	14.6/13.6	14.4/17.8	5.8/9.4
	F3. perineal	6.4/7.6	—	4.8/5.6
	F4. scrotal	9.8	—	3.2
	F5. tail	2.6	8.6	2.0
Thoracic limb	G1. lateral of arm	13.8/15.2	9.2/9.2	8.0/11.2
	G2. lateral of forearm	12.8/10.0	12.4/10.6	6.2/5.8
	G3. medial of arm-forearm	7.4/5.6	7.0/9.4	4.2/4.8
	G4. carpal-metacarpal	6.8/6.2	3.2/3.8	3.0/3.4
Pelvic limb	H1. lateral of thigh	17.2/18.0	17.2/22.4	9.0/8.6
	H2. lateral of leg	11.4/13.8	12.6/12.6	5.8/7.4
	H3. medial of thigh-leg	9.6/8.8	8.4/6.8	4.6/3.6
	H4. tarsal-metatarsal	8.4/6.8	7.0/5.6	5.4/3.2
Mean $\pm$ standard deviation		9.18 $\pm$ 3.23	9.51 $\pm$ 3.83	5.66 $\pm$ 1.18

Unit: Mean of Toruli Tactiles per 2cm square, left/right.

reveal values of about 9.18 and 9.51 for the mean per 2 cm square of all body areas. On the other hand, the mean per 2 cm square in specimen No. 3 (male) was 5.66 smaller than the values for No. 1 and No. 2.

A high density of distribution of TT was seen to extend from the lateral area of the arm to forearm and from the lateral area of the thigh to leg in all specimens. The thigh had the greatest density of TT on the body surface of the goat. The highest density extended to the gluteal area. Also, in particular, the buccal-masseteric area in specimen No. 2 had a fairly high density of TT.

On the other hand, a low density of TT was observed in the facial-cranial region except for the buccal-masseteric area, cranial breast, perineal area (male), axilla, inguen, carpal-metacarpal and tarsal-metatarsal areas. TT were hardly found in the ears, on the nose, around the mouth, perianal skin, palms and soles.

The density of TT in the cervical region and trunk

(thoracic, abdominal, dorsal and pelvic regions), except for some parts, ranged from about 6 to 11 in specimens No. 1 or No. 2 and from about 4 to 7 in specimen No. 3. The values for the density were thus generally similar to the mean per 2 cm square for the whole body surface.

In other animals, TT are known to occur at intervals of about 1 to 2 mm in mice, 3 to 5 mm in rats and guinea pigs, 5 to 10 mm in rabbits and cats, and about 1 per square cm in humans (Straile, 1960; Smith, 1970, 1977). Kamata (1983) noted that TT numbered about 20 per square cm in the lateral abdomen of mice. Iggo (1963) found that the density of TT ranged from 10 to 20 per square cm on the hairy skin of feline limbs and legs. The number of TT per square cm of the goat was thus smaller than that of the mouse, rat and cat. However, the densities of distribution of TT reported by these previous authors referred to only part of the body surface.

Kamide (1955) observed that the nape, scapular area and lateral abdomen have a large number of TT, while the head, metopic area, face and palms have a small number of TT in the human skin. According to Tomponi (1938, 1939), TT in the human skin were most abundant on the neck but were absent from the face, palms, soles and penis. The distribution of TT in the human skin is different from that in some parts of the body surface of the goat. Wakuri *et al.* described in detail the density of distribution of TT in different parts of the body surface of the dog (1987) and Japanese monkey (1988). Most of the high density and low density areas on the body surface of the goat corresponded to those of the dog rather than those of the Japanese monkey or human being.

The present study clearly demonstrated that TT were present in the hairy skin of the goat, and that the density of distribution of TT varied widely according to the area of the body surface.

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References

- 1) Dyce, K. M., Sack, W. O. and Wensing, C. J. G.: Textbook of Veterinary Anatomy, p. 360, W. B. Saunders Co., Philadelphia, London and Toronto, 1987.
- 2) English, K. B.: The ultrastructure of cutaneous type I mechanoreceptor (Haarscheiben) in cats following denervation. *J. Comp. Neurol.*, **172**: 137-164, 1977.
- 3) Evans, H. E. and Christensen, G. C.: Miller's Anatomy of the Dog, 2nd ed., p. 625-626, W. B. Saunders Co., Philadelphia, London and Toronto, 1979.
- 4) Iggo, A.: New specific sensory structure to hairy skin. *Acta Neuroregulation*, **24**: 175-180, 1963.
- 5) Iggo, A. and Muir, J.: The structure of a slowly adapting touch corpuscle in hairy skin. *J. Physiol.*, **200**: 763-796, 1969.
- 6) International Committee on Veterinary Gross Anatomical Nomenclature: Nomina Anatomica Veterinaria, 3rd ed., together with Nomina Histologia (NAV-NH), 2nd ed., p. 13, World Association of Veterinary Anatomists, Ithaca, New York, 1983.
- 7) Kamata, H.: Study of hair disc (Haarscheiben) (I): Morphological observation of hair discs (Haarscheiben) by scanning electron microscopy. *J. Clin. Electron Microsc.*, **16**: 295-301, 1983.
- 8) Kamide, J.: On the finding of skin nerves supravital stained with methylene blue, especially on the Haarscheibe of the human skin. *Jap. J. Dermatol.*, **65**: 339-355, 1955 (in Japanese).
- 9) Kasprzak, H., Tapper, D. N. and Craig, P. H.: Functional development of the tactile pad receptor system. *Exp. Neurol.*, **26**: 439-446, 1970.
- 10) Lovell, J. E. and Getty, R.: The hair follicle, epidermis, dermis and skin gland of the dog. *Amer. J. Vet. Res.*, **18**: 873-885, 1957.
- 11) Mann, S. J.: Haarscheiben in the skin of sheep. *Nature*, **205**: 1228-1229, 1965.
- 12) Nomina Anatomica Veterinaria Japonica (NAVJ): 3rd ed., p. 348, Japanese Association Veterinary Japonica, Tokyo, 1987.
- 13) Pinkus, F.: Ueber einen bisher unbekannten Nebenapparat am Haarsystem des Menschen: Haarscheiben. *Dermatologische Zeitschrift*, **9**: 465-469, 1902.
- 14) Sano, Y.: The-Soshiki-Gaku-Kenkyu-Hou, 6th ed., p. 371-373, Nanzandou Co., Tokyo, 1985 (in Japanese).
- 15) Smith, K. R.: The structure and function of the Haarscheibe. *J. Comp. Neurol.*, **131**: 459-474, 1967.
- 16) Smith, K. R.: The ultrastructure of the human Haarscheibe and Merkel cell. *J. Invest. Dermatol.*, **54**: 150-159, 1970.
- 17) Smith, K. R.: The Haarscheibe. *J. Invest. Dermatol.*, **69**: 68-74, 1977.
- 18) Straile, W. E.: Sensory hair follicle in mammalian skin: The tylotrich follicle. *Amer. J. Anat.*, **106**: 133-148, 1960.
- 19) Tomponi, M.: Ricerche li colorazione sopravvitalle della cute: Osservazioni sulla fine innervazione dell' Haarscheibe (disco del pelo) di Pinkus, con particolare riguardo all' esistenze in corrispondenza di esso li una espansione nervosa terminale non ancora descritta. *Arch. Ital. Dermatol.*, **14**: 499-536, 1938.
- 20) Tomponi, M.: Nuovo contributo alla conoscenza del "disco del Pelo" (Haarscheibe di Pinkus), con particolare riguardo alla sua iconografia macroscopica. *Arch. Ital. Dermatol.*, **15**: 378-394, 1939.
- 21) Wakuri, H. and Narita, M.: The microscopic anatomy on the Torulus Tactilis of the dog. *Kitasato Arch. Exp. Med.*, **59**: 115-127, 1986.
- 22) Wakuri, H., Mutoh, K. and Narita, M.: Density of Toruli tactiles in the dog. *Okajimas Folia Anat.*, **64**: 71-80, 1987.
- 23) Wakuri, H.: Density of Toruli tactiles in the Japanese monkey. *Anat. Histol. Embryol.*, **17**: 312-318, 1988.

Explanation of Figures

Plate I

Fig. 1. Photograph showing Toruli Tactiles (arrowheads; with abundant dark papilla-like structures) on the skin stained with methylene blue. Scale, 1 mm.

Plate II

Fig. 2. Photograph showing the distribution of marked TT in specimen No. 2. Lateral view.