

Density And Structural Variations Of Meissner's Corpuscle At Different Sites In Human Glabrous Skin

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Abstract : The study was conducted on the skin samples obtained from glabrous human skin to find out study the density and structure of Meissner's corpuscle (MC) at different sites like finger tips, palm, front of forearm, sole, lips, prepuce of penis, dorsum of hand and dorsum of foot. The skin samples were taken from sixty persons (with age range of 2-72 years); 5 µm thick section were prepared, impregnated with silver and observed under compound light microscope. Density of the MCs was studied by calculating Meissner's Index (MI). Different sites had different MIs, which ranged from 0.28 to 0.96. The highest MI was observed at the finger tip and lowest at the prepuce of penis. The shape and size of the MC has direct relationship with its site and function. Largest size of the MC was at finger tip (120-260 x 64-84 µm) and the smallest at prepuce of penis (66-84 x 38-52 µm). In less tactile areas like dorsum of hand and foot, the shape of the MC was globular and its structure simple while as in more sensitive areas like finger tips, the shape changed to oval or cylindrical form with complex structure.

Key words: Meissner's corpuscle, Meissner's Index, skin, finger tip, sole, tactile corpuscle

Introduction :

Skin has a rich afferent nerve supply but the density of innervation varies from region to region. The surface of skin actively concerned with tactile exploration, such as palmar aspect of hand and sole, have well organized pattern of ridges and rich nerve supply in the form of sensory receptors; in contrast to the more uniform and less differentiated skin surface covering the greater part of the body which contains hair as sensory organ (Iggo, 1977). Meissner's corpuscle (MC), the most complex cutaneous receptor, has been of interest to many morphologists since the original description by Wagener and Meissner in 1852. Silver impregnated MC observed by conventional light microscopy shows very characteristic organization of the neural component (Castano *et al.*, 1995). The afferent nerve fibres (2-6) branch out into a complicated system of nerve endings arranged spirally, sandwiched between lamellar (schwann) cells and collagen fibres surrounded by a well defined capsule of collagen fibres and capsular (fibrocyte type) cells (Cauna, 1956a, b; Castano *et al.*, 1995).

Although MCs have been reported to be present at various hairless sites, no study has been conducted to assess the density and morphological features of MCs at sites other than finger tips and palm. The present study was undertaken to compare the structure and density of MCs at different sites of glabrous skin.

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Material And Methods :

The study material comprised of skin samples from glabrous skin of sixty persons (age range 2-72 years) operated in the associated hospitals of Govt. Medical College, Srinagar, Jammu and Kashmir, India. The samples were collected from finger tips, palm, sole, front of forearm, dorsum of foot, dorsum of hand and prepuce of penis. The skin samples were collected as biopsy material, cut into 1x1 cm pieces, fixed in 10 per cent buffered formalin solution and embedded in paraffin wax. Five µm thick sections were cut and impregnated with silver (Winkelmann and Schmit, 1951).

For quantitative analysis of MCs, sections perpendicular to the skin surface were used. MCs were counted while observing (at 100 x magnification) under compound light microscope fitted with a measuring scale in the ocular lens for measuring various dimensions. The number of MCs divided by the number of epidermal ridges is called Meissner's Index (Dickens *et al.*, 1963). Meissner's index (MI) was used in this study, as it is much simpler way of comparing individuals/sites with different Meissner's counts than are counts per unit area. The need to use correction factors for shrinkage and fixation are also eliminated. The data regarding MI and size of the MCs in more sensitive areas (finger tips, palm, sole and lips) and less sensitive areas (front of forearm, dorsum of hand, dorsum of foot and prepuce of penis) was subjected to statistical analysis by using Students t-test. The morphological aspects of the MCs were studied while observing at x400 magnification.

Observations :

The Meissner's indices for different sites ranged from 0.28 to 0.96 (Table 1). MCs were seen in abundance in finger tips, palm and sole. The

maximum number of MCs was seen in palmar aspect of finger tip as revealed by MI value of 0.96, followed by palm (0.94), sole (0.94) and the lowest MI of 0.28 was observed in preputium of penis. The MCs were also observed on the dorsum of hand and dorsum of foot but their number was considerably reduced (range from 0.33 to 0.56) compared to that of palmar or plantar skin (Table 1). The difference between the MI of more sensitive sites and of less sensitive sites was statistically significant (t-value =3.26).

It was observed that the size of the MC varied at different sites. The size of the MCs at finger tips, palm, lips and sole were larger than those of prepuce of penis, dorsum of hand and dorsum of foot (Table 1). The difference of means for size of MCs of the more sensitive sites and less sensitive sites was significant (t=5.016, Table 2). The shape of the MC also varied at the different sites. The MCs of finger tip were oval, oblong or cylindrical (Fig. 2), that of palm and lip oval (Fig. 3) front of forearm globular, prepuce of penis globular to oval and that of sole irregularly oval or sometimes triangular (Fig. 4).

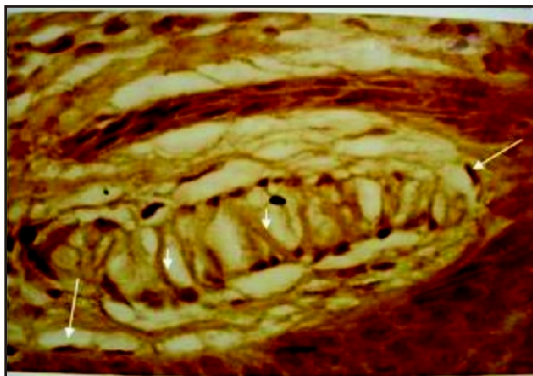


Fig. 1 : Longitudinal section of MC from the plantar aspect of great toe of 30 year male showing well defined capsule with capsular cells (arrows) and core of helically arranged nerve fibres (arrow head) (Silver stain 400 x).

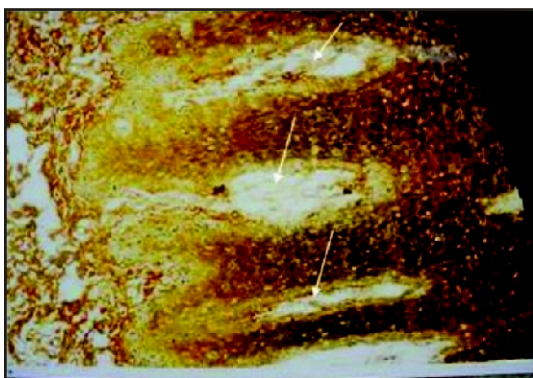


Fig. 2 : Longitudinal section of skin from finger tips of 41 year of male showing three MCs having well defined capsules (arrows). The shape is oval or cylindrical (Silver stain 100 x).

Table 1
Showing Meissner's index and size of Meissner's Corpuscle at different sites.

Site of Biopsy	No. of specimens	Meissner's index (Range)	Size of Meissner's corpuscle L x B (Range in m)
Finger tip	15	0.40 - 0.96	120-260 x 64-84
Palm	10	0.60 - 0.94	116-230 x 60-78
Sole	08	0.70 - 0.94	160-230 x 48-80
Lip	06	0.75 - 0.90	158-170 x 48-59
Front for forearm	05	0.65 - 0.86	82-100 x 58-66
Dorsum of hand	03	0.47 - 0.56	90-100 x 48-56
Dorsum of foot	05	0.33 - 0.51	70- 80 x 38-66
Preputium of penis	08	0.28 - 0.35	64- 84 x 38-50

Table 2
Showing significance of the differences in the means of MIs and size of the MCs in more sensitive sites (group A) and less sensitive sites (group B)

Parameter	No. of sites		Mean		Degrees of freedom (d.f.)	t-value	Significance	
	A	B	A	B				
Meissner's Index	4	4	0.831	0.5105	6	3.26	Significant at 5% level	
Size	4	4	185.0825	83.725	6	9.37	Significant at 0.1% level	
								a) Length
								b) Breadth
c) Size	4	4	1245.334	4345.3275	6	5.016	Significant at 1% level	

It was also observed that the MCs of finger tips, palm and sole showed more complicated pattern of nerve fibres inside the corpuscle and there were more nerve varicosities and end bulb formations. The capsule of MCs at these sites was well defined with conspicuous capsular cells (Fig. 1). In prepuce of penis, dorsum of hand and dorsum of foot there was less coiling of nerve fibres inside the core of the MC and thus the transverse striations were less prominent. The capsule was ill defined, thin and capsular cells could not be identified clearly.

Discussion :

The architecture and structure of the MC of man has been described by various authors in the finger tip and palm (Cauna, 1956b, Miller *et al.*, 1958; Cauna and Ross, 1960; Hashimoto, 1975 and Castano *et al.*, 1995). Human MCs have been uman

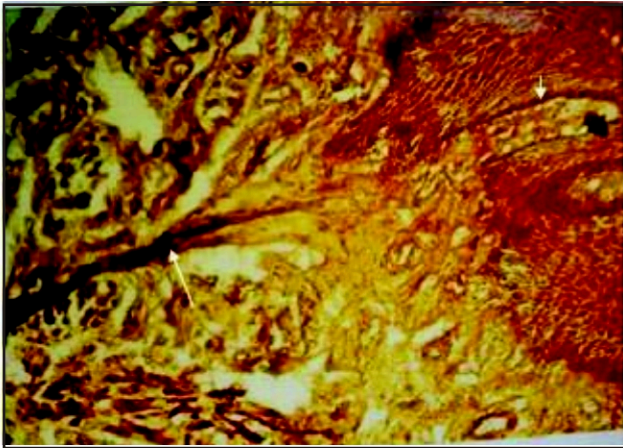


Fig.3 : Longitudinal section of lip skin from 8 year male showing a thick nerve bundle dividing into three branches (arrow). Central branch ascends up and supplies a MC (arrow head) (Silver stain 100 x).

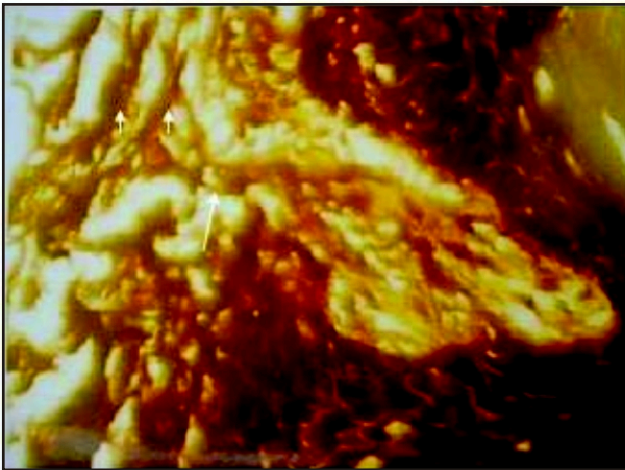


Fig.4.: Longitudinal section of MC from the sole of 65 year male showing two nerve fibres (arrow) arising from sub papillary nerve plexus (arrow heads) and branching inside an irregularly oval MC (Silver stain 400 x).

compared with the MCs in rat snout (Macintosh, 1975; Macintosh and Sinclair, 1978), mouse digital pads (Mathewson and Nova, 1985), finger tips of green monkey (Casteno *et al.*, 1978) and snout of pig (Fitzgarald, 1962). Changes have been reported in the human MCs because of aging (Cauna, 1956; Ridly, 1969) and disease (Dickens *et al.*, 1963; Hunter *et al.*, 1969). However, the comparison of human MCs at different sites of glabrous skin has not been reported.

The present study depicted that maximum density of MCs was at finger tips (MI of 0.96) followed by palm (MI of 0.94) and forearm 0.86. This finding is in accordance to Johansson and Vallbo (1979) who studied the tactile sensitivity in human hand and concluded that the density of MCs is higher at the

finger tip than at the palm, making fine manipulatory movements possible by the finger tips and thereby helping in tactile localization. Sole and lips showed MI of 0.70-0.94 and 0.75-0.90, respectively; showing that these organs are very sensitive to touch. MCs are also present in skin of front of forearm, dorsum of hand, dorsum of foot and prepuce of penis but their MI (i.e., density) is less compared to that of finger tips and sole, pointing to the fact that these sites are less sensitive to touch (Table 2). The difference between the mean of more sensitive sites and less sensitive sites ($t=3.26$) was significant ($p < 0.05$).

Size of the MC also varied at different sites. Largest size of the MC was found in skin of finger tip, palm and sole which is in collaboration to their tactile role. Size of the MC in finger tip was found to be 120-260 x 64-84 μm , whereas Guinard *et al.* (2000), using immuno labelling of the MC, found the size to be 30-140 x 20-60 μm . The size of the MC is small in prepuce of penis, front of forearm, dorsum of hand and dorsum of foot which explains their less sensitivity to touch (Table 1).

Various authors have described the shape of the MC differently viz. cylindrical (Cauna, 1956), ovoid (Ridley, 1969), ellipsoid (Johansson and Fantini, 1999). In the present study, it was found that shape of the MC has special relationship with its site and function. The shape of the MC at sites of less sensitivity like dorsum of hand, dorsum of foot, prepuce of penis is usually globular, that of the more sensitive areas like lip and palm oval and that of the highly sensitive areas like finger tips the shape can be oval, oblong or cylindrical. In sole, the shape of MC is irregularly oval or triangular because of its presence in weight bearing area of the body.

In more sensitive sites like finger tip and sole, the MCs are well developed, having a well defined capsule with prominent capsular cells and there is extreme coiling of the nerve fibres inside the MC, compared with less sensitive areas like front of forearm in which MCs are less discrete, the capsule is poorly developed, nerve fibers take less tortuous course and transverse striations are faint.

From the above study we conclude that MCs in less sensitive areas of the body have less density with small size, globular shape and simple structure whereas in more sensitive areas the density is more, size is large, shape changes to oval, oblong or even cylindrical with complex structure.

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