

Research Article

Quantitative and qualitative changes in human Meissner's corpuscle at different ages: a light microscopic analysis

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ABSTRACT

Background: Meissner's corpuscle is the most complex sensory receptors of the skin; providing information about rapidly fluctuating mechanical forces acting on the hairless skin. Aim of current study was to study density and structural changes in human Meissner's corpuscles at different ages

Methods: Samples were obtained from finger tips of fifteen persons and divided into three groups according to age: group A <15years; group B: 16-45 years and group C: 46-72 years. 5 µm thick sections were prepared, impregnated with silver and observed under compound light microscope. Density of Meissner's corpuscles (Mcs) was studied by calculating Meissner's Index (MI).

Results: In group A, the MI was 0.86-0.90, which increased to 0.96 in group B and dropped in group C to 0.4 (in the seventh decade). The analysis of variance showed significant difference ($P = 0.019$) in MIs of the three age groups. The size of the Mcs was largest in group B, followed by group C and smallest in group A. The analysis of variance showed that there was highly significant difference ($P = 0.003$) between the size of Mcs in all the three age groups. It was observed that morphology of Mcs alter with age. In children these consisted of rudimentary coil of nerve fibers around collection of cells. In adults the intra-corporcular nerve fibers were compressed into a tight spiral and modifications of nerve fibers, like end bulbs, varicosities and networks, were well developed. In old age Mcs were attenuated consisting of tangled mass of nerve fibers.

Conclusion: It can be concluded that in adults the Mcs are greater in number, larger in size and complicated in structure, compared to young and old people.

Keywords: Glabrous skin, Meissner's corpuscle, Meissner's index, Age changes

INTRODUCTION

Sensory receptors are terminal nerve endings of afferent nerve fibers in association with cells of the surrounding tissue. From structural point of view, cutaneous receptors can be non-encapsulated like free nerve endings, Merkel's discs, nerve endings related to hair follicles or encapsulated like Meissner's corpuscles, Pacinian corpuscles, Ruffini corpuscles and Krause bulbous corpuscles.^{1,2} Among the cutaneous receptors, Meissner's

corpuscle (Mc) is the most complex structural entity, providing information about rapidly fluctuating mechanical forces acting on the hairless skin. The Mcs are particularly sensitive to vibrations ranging from 10-4000 HZ, with maximum sensitivity between 100-200 HZ.³

Corpuscula-tacti (i.e. Mcs) are present in dermal papillae of palmer surface of fingers, palm, sole, front of forearm, lips, eyelids, palpebral conjunctiva, mucous membrane of

apical part of tongue, preputium of penis and nipples. Mcs of finger tips are highly developed, being globular, oval or cylindrical structures, measuring 150-200x 40-70 µm in size. Each Mc has a capsule surrounding core of helically arranged nerve fibers, sandwiched by Schwann cells and collagen fibers. The capsule is derived from the tissue of dermal papilla and is interspersed with flattened capsular cells. Each Mc is supplied by 2-6 thickly medullated nerve fibers from the corial plexus of nerves. Within the core, the nerve fibers ramify towards the epidermal pole and on their way from various modifications like nerve varicosities (thickenings), end bulbs and neurofibrillar networks.⁴⁻⁷

Aim of study

Meissner’s corpuscles undergo structural changes as the age advance or in some diseases like neuropathies. The aim of the present study was to study Mcs of finger tips and compare their structure and density at different ages.

METHODS

The study material comprised samples from glabrous skin of finger tips of fifteen persons (age range 2-72) years. The patients were divided into three age groups: group A <15 years; group B 16-45 years and group C 46-72 years. Skin samples were cut into 1x1 cm pieces, fixed in 10% buffered formalin solution and embedded in paraffin wax. Five µm thick sections were prepared and impregnated with silver by Winkelman technique.⁸

For quantitative analysis of Mcs, sections perpendicular to the skin surface were used. Mcs were counted while observing at x100 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.⁹ Meissner’s index (MI) was used in the present study as it is much simpler way of comparing individuals with different Mc counts than are counts per unit area, as the need to use correction factors for shrinkage and fixation are eliminated. The morphological aspects of Mcs at different ages were studied while observing at x400 magnification.

The MI was calculated for all sections to quantify whether there is any difference in the three age groups. The data regarding the MI and size of the Mcs was subjected to statistical analysis by using analysis of variance for comparing the three age groups

RESULTS

Quantitative changes

To find any variations in the density of Mcs in different ages, MI was calculated for all sections. It was observed that almost all papillae of infants and children contained Mcs, but in old age these end organs became

progressively less numerous. In group A, the MI was 0.86 to 0.90, which increased to 0.96 and remained more or less static. In group B MI fell to 0.5 in the Sixth decade and to just 0.4 in the seventh decade. The analysis of variance of the MI in the three age groups is shown in Table 1. The mean MI and least significant difference (lsd) in the three age groups is shown in Table 2. In children there were one to three Mcs per papilla (Figure 1); later in life, the number of Mcs per papilla decreased, till in old age some papillae contained one or two Mcs, while others were devoid of them (Figure 2).

Table 1: Analysis of variance (balanced designs) for Meissner's index.

Source	DF	SS	MSS	F	P
Age	2	0.19853	0.09927	5.64	0.019*
Error	12	0.21107	0.01759	-	-
Total	14	-	-	-	-

DE: Degree of freedom, SS: Sum of squares, MSS: Mean sum of squares.

Table 2: Mean Meissner's index and lsd values for 3 age groups.

Age group	No. of Individuals	Mean Meissner's index	Difference of mean Meissner's Index	lsd value
Group A	3	0.86000	Between A and B = 0.0767	0.2043
Group B	6	0.93667	Between A and C = 0.1767	0.2043
Group C	6	0.68333	Between B and C = 0.2533	0.1668

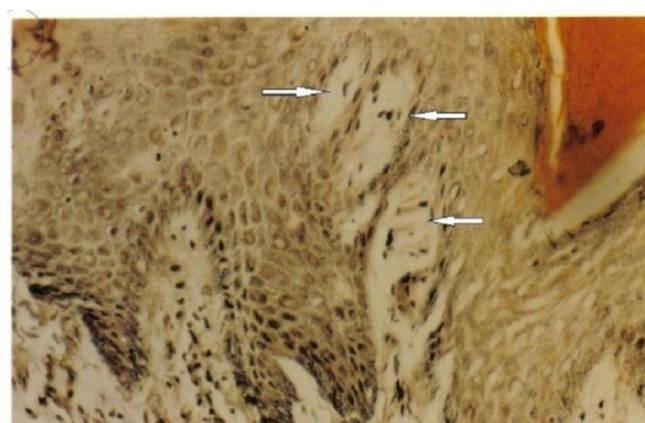


Figure 1: Section of skin from finger tip of 15 years female showing three Mcs (arrows) in a single dermal papilla (Silver stain x200).

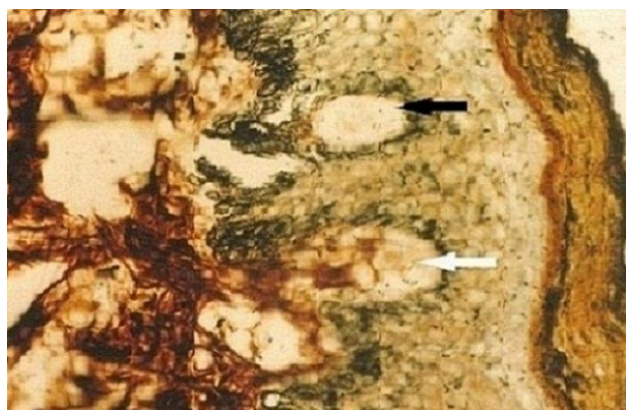


Figure 2: Section of skin from finger tip of 60 years of male showing one Mc devoid of nerve fibers (black arrow) and another Mc containing tangled nerve fibers (white arrow) (silver stain x100).

Qualitative changes

It was observed that in young individuals, the upper end of the Mc was in direct contact with basal epidermal cells. As the age advanced, the Mcs gradually descended deeper into the dermal papillae and at a later age, the skin showed a zone of indistinct cells and connective tissue between the basal epidermal cells and superficial pole of the Mc (Figure 3).

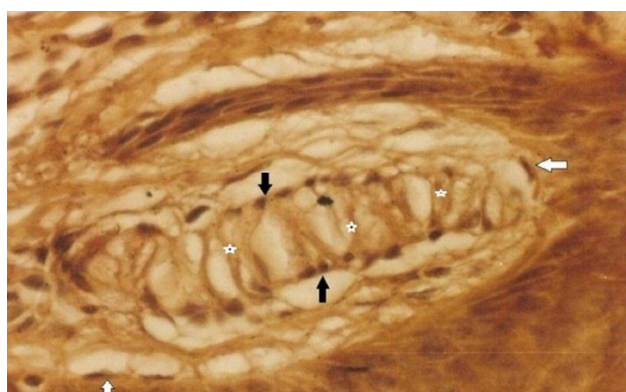


Figure 3: Section of human skin from finger tip of 35 year male showing a typical Meissner's corpuscle with spindle shaped capsular cells (white arrow), Nerve fibers (star) and lamellar cells (black arrows) (silver impregnation x400).

The size of the Mcs was small in group A (120-130x 64-76 μm) and size increased in group B (168-260x 78-80 μm) The analysis of variance for testing the differences in size of Mcs in three age groups is shown in Table 3. The mean size of the Mcs and Isd values in the three age groups is shown in Table 4.

Comparing the capsule of Mc at different ages, it was observed that in early age the capsule was as a thin layer around the core. The capsule was fully formed at puberty and remained unaltered in the adult age, in which the

collagen fibers of the capsule and flattened capsular cells were quite distinct (Figure 4). The capsule persisted as long as long as the corpuscle persisted in old age. It was observed that in early age, the Mcs consisted of a rudimentary coil of nerve fibers around collection of cells. In children, the nerve endings were observed throughout the corpuscle (Figure 1). In adults, the corial half of the receptor consisted of coarser nerve fibers, which moved up towards the epidermal pole in a helical manner between fine collagen fibers of the core. The Schwann (lamellar) cells sandwiched the nerve fibers. On their way, the nerve fibers got modified to form end bulbs, varicosities (thickenings) and nerve networks. In old age, the nerve fibers were concentrated in the superficial pole of the Mc and some of the Mcs were degenerate, consisting of tangled mass of nerve fibers (Figure 2).

Table 3: Analysis of variance for size of the Meissner's corpuscle.

Source	DF in sq. μm	SS in sq. μm	MSS	F	P
Age	2	206523764	103261882	9.52	0.003*
Error	12	129664955	10805413	-	-
Total	14	336188719	-	-	-

Table 4: Mean size of Meissner's corpuscles and Isd values for three age groups.

Age group	No. of Individuals	Mean Meissner's corpuscles	Difference of mean (sq. μm)	Isd value
Group A	3	8544	A and B = 7943	5064.3423
Group B	6	16487	A and C = 10019	5064.3423
Group C	6	18563	B and C = 2076	4135.0182

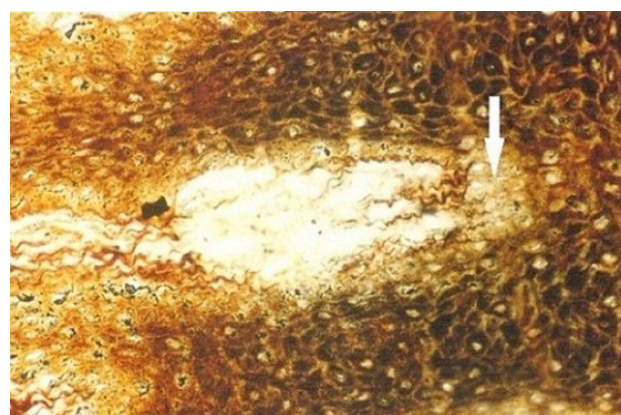


Figure 4: Section of skin from the finger tip of 55 years male, showing zone of indistinct cells (arrow) between basal epidermal layer and upper pole of Mc (silver stain x200).

DISCUSSION

Quantitative analysis

Mcs undergo degenerative changes as age advances or in diseases like neuropathies.⁹ In the present study, it was observed that all the dermal papillae of young age contained Mcs, but in adults and old people these end organs became progressively scanty in number. First detailed quantitative study of Mcs was that of Dickens et al. (1963).⁹ They biopsied 37 human digits and using cholinesterase technique, they found that the MI fell from 0.9 at 15 years to just 0.3 in the eighth decade. The present findings, i. e. 0.86 to 0.9 in the young age and 0.4 in the seventh decade, correspond to these values. In the present study, the MI remained more or less static (0.86 to 0.9) in the young age and then increased to 0.96 and this ratio remained the same in the middle age. MI progressively fell in the fourth decade and dropped down to 0.5 in the sixth decade and 0.4 in the seventh decade. Dickens et al. (1963)⁹ reported that the fall of MI began in the second decade, but in the present study, it was observed that the fall of MI started in the fourth decade and dropped down to 0.5 in the sixth decade and 0.4 in the seventh decade. Bolten et al. (1966)¹⁰ also carried out quantitative analysis of the Mcs and reported a decrease in the number of corpuscles per square mm with increasing age. He found that the rate of decrease was greater in younger age. They attributed the decrease during the growing years to increase in size of the digit. The present observations do not depend upon the density per unit area but upon the density per epidermal ridge and are therefore independent of digital growth, because the number of epidermal ridges does not change after birth.¹¹⁻¹³ It proves the observation of the present study that reduction in the number of Mcs begins in the fourth decade and not at an early age.

Statistical analysis using one way analysis of variance (ANOVA) showed that on the average, there is significant difference ($P = 0.019$) in MIs among the three age groups (Table 1). The least significant difference (Isd) for the group A and group B (0.2043) and group A and group C (0.2043) is greater than their respective differences of means i.e. 0.0767 and 0.1767, there by showing that these age group pairs are at par with each other (Table 2). However, the Isd value for group B and group C (0.1668) is less than the difference of their means (i.e. 0.2533), showing that they differ significantly from each other.

Qualitative analysis

The size of Mc was largest in group B. Analysis of the variance for testing the difference of size of Mcs in three age groups of man revealed that on the average, there is highly significant difference ($P = 0.003$) in all the three age groups (Table 3, 4). The least significant difference (Isd) value for group A and group B (5064.3423 sq. μm) are less than their respective difference of means i.e.

7943 sq. μm and 10019 sq. μm), there by showing that the two age group pairs differ significantly with respect to size of Mcs. However the Isd value for group B and group C (4135.0182 sq. μm) is greater than the difference of their means (i.e. 2076 sq. μm) thereby showing that the number of the Mcs in group B and group C are at par with each other.

The changing morphology of Mcs with age as described by Cauna (1956)⁵ and Ridley (1969)⁶ support the present observations. In infants the Mc is rudimentary coil of nerve fibers with faintly visible capsule. In children, the nerve fibers are present throughout the Mc with a thin capsule. In adults the corial half of Mc show coarse nerve fibers with well-developed capsule and in old age, some Mcs are found degenerated consisting of tangled mass of nerve fibers but the capsule persisted.

CONCLUSION

From the above discussion we conclude that:

- All the dermal papillae of infants and children contain Mcs, but as age advances these end organs become progressively scanty ($P=0.019$).
- Morphology of Mcs alter with age, in children, these consist of rudimentary coil of nerve fibers around collection of cells. In adults, the intra corpuscular nerve fibers are compressed into a tight spiral. In old age, the corpuscles are attenuated consisting of tangled mass of nerve fibers.
- Largest size of Mcs is in adults ($P=0.003$).

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