International Journal of Research in Medical Sciences
Bhat GM et al. Int J Res Med Sci. 2013 Nov;1(4):409-412
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012

DOI: 10.5455/2320-6012.ijrms20131118

Research Article

Structural organization and pattern of innervations of human Meissner's corpuscle: a light microscopic study

Gh. Mohd. Bhat*, Naseer Ahmad Shah, Mohd. Saleem Itoo, Bashir Ahmad Shah, Shaheen Shahdad, Javeed Ahmad Khan

Department of Anatomy, Government Medical College, Srinagar-190001, J & K, India

Received: 15 July 2013
Accepted: 4 August 2013

***Correspondence:**
Dr. Ghulam Mohd Bhat,
E-mail: gmbhat144@gmail.com

ABSTRACT

Background: Human glabrous skin has very rich nerve supply in the form of specialized nerve endings like Meissner's corpuscles, Pacinian corpuscles, Krause end bulbs etc for carrying sensory information to brain**.**
Aim of study: To study the structure, pattern of innervations and nerve terminations of human Meissner's corpuscle.
Methods: Skin samples from sixty human beings (age range 2 to 72 years) were taken, sections prepared and stained with a cytological (Haematoxylin – Eosin and Vongieson's stains) and a neural stain (Silver Impregnation).
Results: With cytological stain, Meissner's corpuscles were seen in dermal papillae of glabrous skin, each consisting of a cellular structure having a peripheral capsule and central core of transversely arranged cells. With neural stain, each corpuscle was seen to be oval, globular or cylindrical structure, having a capsule surrounding the core of spirally arranged nerve fibers, sandwiched by Schwann cells. In between nerve fibers of the core were seen small bundles of collagen fibers. 2-6 nerve fibers innervated each Mc from the sub corial plexus of nerves and formed various patterns of nerve endings like networks, end bulbs and varicosities inside the Meissner's corpuscle**.**
Conclusion: Meissner's corpuscle is a complex structure composed of capsule - consisting of spindle shaped capsular cells interspersed in collagen fibers, surrounding a core of helically arranged nerve fibers, Schwann cells and collagen fibers.

Keywords: Meissner's corpuscle, Glabrous skin, Silver impregnation, Capsule, Core

INTRODUCTION

Skin is the largest organ of the body having surface area of 8-16%. It can be divided into two types: (a) Thin hairy skin (Hirsute skin) which covers the greater part of the body and (b) Thick hairless skin (Glabrous skin) present in palm of hands, sole of feet and flexor surface of digits. Glabrous skin needs extra strength for manipulation and locomotion. It also possesses numerous sweat glands for cooling and a rich nerve supply for sensory function. The nerve supply of glabrous skin is arranged in specialized manner called sensory receptors. Each receptor is made up of afferent nerve endings in a special kind of association with cells of the surrounding tissue.[1] Glabrous skin has dermatoglyphic pattern i.e., the skin is covered with ridges and grooves. Under each primary epidermal ridge, there is a corresponding primary dermal ridge. Each primary dermal ridge is subdivided into two secondary dermal ridges. Projecting from the top of secondary dermal ridges there are several rows of relatively tall conical projections that are known as dermal papillae.

The anatomy of human sensory nerve endings has been extensively studied and has provided a lively source of debate amongst histologists for a long period of time. From the structural point of view, cutaneous afferent endings fall into two categories: (a) Non encapsulated

receptors like free nerve endings, Merkel's discs; and (b) Encapsulated receptors like Meissner's corpuscles (Mc), Pacinian corpuscles, Ruffini corpuscles, Bulbous corpuscles of Krause etc.[2]

Aim of study

Meissner's corpuscle is one of the most complex cutaneous receptors. Its nerve supply and manner of nerve termination has been the subject of extensive investigation and controversy. The aim of the present study was to study Meissner's corpuscle in man, with regard to its structural organization, pattern of its nerve supply and nerve termination.

METHODS

The study material comprised of skin samples from fingertips, palm, lips and sole; which were collected from sixty human beings (age range 2-72 years). The skin pieces were cut into 1x1 cm pieces, fixed in 10 per cent phosphate buffered formalin solution and embedded in paraffin wax, 5 µm thick sections were prepared stained with a cytological stain like Haematoxylin-Eosin or Von Gieson's stain and a neural stain like silver impregnation according to modified version of the method described by Winkelman.[3] The sections were cleared of wax by treating with xylene for 1-2 minutes, flooded with absolute alcohol for 30 seconds and rinsed in distilled water for two changes. Then the sections were treated with 20 per cent silver nitrate at 37°C for 25-30 minutes and rinsed in distilled water, then flooded twice, 10 second each time, with 10 per cent formalin in tap water, impregnated with ammoniacal silver for 30 seconds, drained off silver solution and flooded slide with two changes of 10 per cent formalin for 1 minute each and rinsed in distilled water, fixed in 5 per cent sodium thiosulphate for 5 minutes to remove precipitated silver and washed in tap water, dehydrated through 70 per cent , 95 per cent and absolute alcohol (30 seconds in each), cleared in xylene for 1 minute and mounted in synthetic resin. For quantitative analysis of Mcs, sections perpendicular to the skin surface were used and observed under x100 magnification undercompound light microscope fitted with a measuring scale in the ocular lens for measuring various dimensions (micrometry). The morphological aspects of Mc like number of nerve fibers entering, ramification and tortuosity etc. were studied, while observing at x400 magnification. In some cases horizontal sections were used to study the nerve fibers.

RESULTS

The sections stained with cytological stain showed that the skin surface was thrown into elevations called epidermal ridges. In between two epidermal ridges was the epidermal groove. Below epidermal ridges, the dermis is pushed up into epidermis as in-growths called dermal papillae, which divide the epidermal groove, into the secondary segments. The dermal papillae showed the presence of Mcs. Each Mc consisted of cellular structure, having a core of deeply staining oval to spindle shaped nuclei, arranged parallel to the skin surface and a capsule formed by the papillary tissue having fibrillar network, arranged parallel to the long axis of the corpuscle. The capsule did not surround the deeper (corial) end of the corpuscle and the core seemed to be continuous with the dermal tissue. The fibrillar network of the capsule was interspersed with capsular cells having elongated nuclei and deeply staining chromatin (Figure 1). In between the cells of the core were fine network of collagen fibers. Occasionally there were arterioles close to the dermal pole of the corpuscle. When the sections were impregnated with silver, nerve fibers were seen in dermis, going up into dermal papillae and sometimes innervating the Meissner's corpuscle (Figure 2).

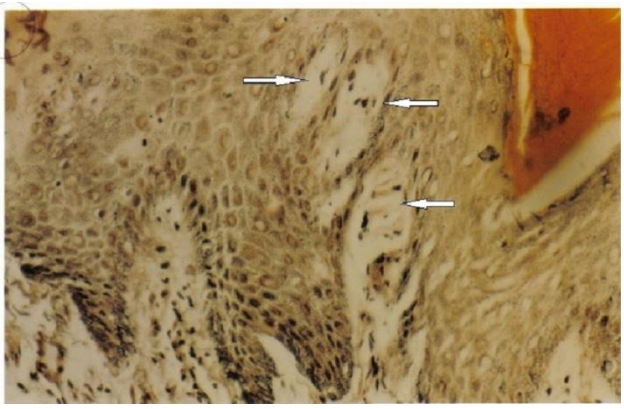

Figure 1: Longitudinal section of skin from plantar aspect of great toe of 15 years female showing three Mcs (arrows) in a single dermal papilla. (VonGieson's stain x 200).

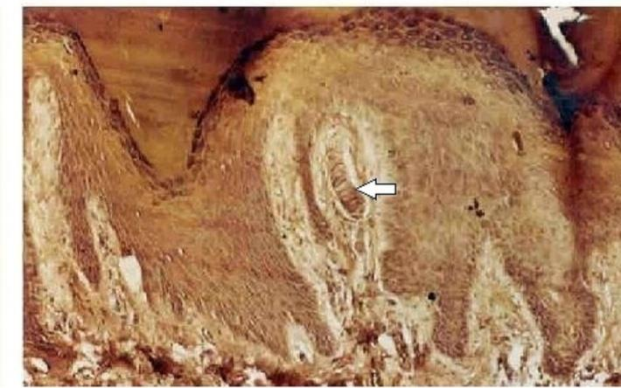

Figure 2: Longitudinal section of human skin from plantar aspect of great toe of 30 year male showing a typical Meissner's corpuscle (arrow) having capsule and core of helically arranged nerve fibers (silver impregnation x100).

Deep Corial Nerve Plexus

It was observed that in the reticular layer of the dermis there is a network of interconnected nerve bundles

usually arranged parallel to the skin surface but sometimes forming a mesh like structure. It was formed from branches of the collateral nerves (digital, labial etc.). The nerve fibers were 1 to 4 µm in diameter, and the length of nerve bundle reached up to 120 µm. The bundles meet at various angles forming junctions. Each nerve fiber may divide into 1 to 3 branches. Because of frequent divisions, the nerve fibers change their course at random; axonal areas overlap; making it difficult to suggest how many axons took part in the supply of a single Mc. It was observed that from the deep corial plexus of nerves, short nerve trunks arose and got confined in the reticular layer of the dermis forming sub papillary nerve plexus. From sub papillary plexus, nerves arose and formed a very characteristic organization of the neural component of the Mc (Figure 2).

The Capsule of Meissner's Corpuscle

It was observed that Mc consists of a core, surrounded by a well defined capsule of fine branching fibrils, arranged parallel to its long axis. The capsule did not surround either the superficial (epidermal) or deeper (corial) pole of the Mc. At the superficial end of the corpuscle the fibrils of the capsule interlocked with the basal layer of the epidermis. At the corial end of the corpuscle, the capsule widens splits and becomes continuous with the connective tissue of the dermis. Through the basal split portion of the capsule enter the nerve fibers. The fibril network of the capsule is interspersed with capsular cells having flattered bodies and deeply stained chromatin, clearly visible with silver impregnation (Figure 3).

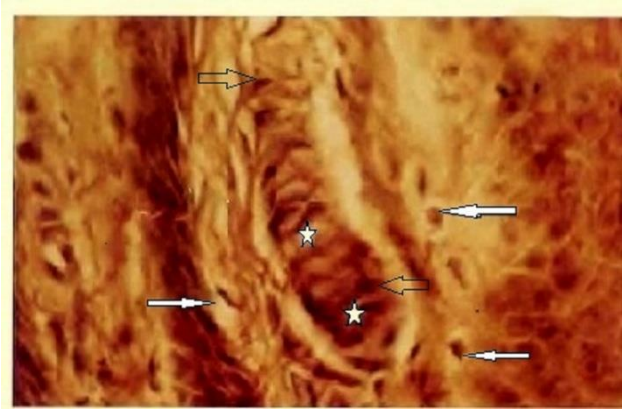

Figure 3: High magnification of the Meissner's corpuscle from the same source as Figure 2 showing capsule with spindle shaped capsular cells (white arrow), Nerve fibers (star) and lamellar cells (hallow arrows) (silver impregnation x 400).

The Core of Meissner's Corpuscle

It was observed that from the sub-papillary plexus of nerves, 2 to 6 nerve fibers arise and supply the Mc. The nerve supply of a single Mc may be derived from one, two or sometimes three sources. Each axon may undergo dichotomous division at the base of the dermal papilla and supply two Mcs of the same segment. Myelinated nerve fibers entering the base of each Mc in a wavy fashion loose myelin sheath and ramify inside the Mc forming ascending spirals (Figure 3). The nerve fibers in the core are surrounded by the interlaced stack of lamellar cells (Schwann cells). Inside the core the terminal ramification did not form plain endings but produced specialized terminations like: Neuro-fibrillar networks, closed end bulbs and Neurofibrillar varicosities (Figure 4). In neurofibrillar networks, the nerve fibers divided and formed a mesh like structure; in closed end bulbs the nerve fibers terminally expand into a bulb like structure; while as in neurofibrillar varicosities, the nerve fibers expanded into a bead like structure which again tapered into the nerve fiber (Figure 4).

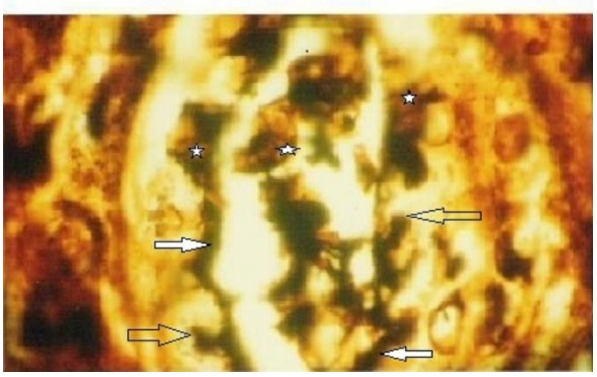

Figure 4: Transverse section of Meissner's corpuscle from lip showing different types of nerve fibers: bulbous enlargements (hallow arrows), nerve thickenings (solid arrows) and neurofibrillar networks (star) (Silver impregnation 1000 x).

DISCUSSION

The Mc, one of the most complex cutaneous receptors, was originally described by Wagener and Meissner in 1852.[4] Mc has been described by various authors.[5-9] In the present study in addition to cytological stains (like Haematoxylin- Eosin and Von Gieson), neural stain like silver impregnation was routinely used. In spite of certain defects, silver impregnation provides useful information concerning the distribution and morphology both of efferent and sensory nerve fibers and also of complex nerve formations such as Mcs and other sensory receptors of the skin.[10]

The present study showed that Mcs are discrete structures present in the dermal papillae of glabrous skin. Each dermal papilla contains 1 to 3 Mcs (Figure 1), though Miller et al (1958),[8] reported up to 7 Mcs per papilla. Each Mc varies in size from 120-260x64-84 µm. With cytological stains, Mcs appear to be cellular structures (Figure 1) but with silver impregnation, nerve fibers are seen clearly going up from the dermal plexus of nerves and branching inside the Mc (Figure 3). All the Mcs have a well-defined capsule surrounding core of spirally arranged nerve fibers. The original description of Mc by

Wagener and Meissner (1852),[4] made no mention of the capsule. It was later on suggested by Krause (1881),[11] that Mc consisted of cellular inner bulb and capsule derived from perineurium. The capsule is deficient both at upper and lower poles of the corpuscle. At the basal end, the capsule splits for the entrance of nerves. Olle Johansson (1999),[12] also confirmed that the capsule of Mc is incomplete. The capsule is composed of fine fibrils of collagen in which are interspersed small branching capsular cells. The capsular cells are of fibrocyte variety, which is in conformity with Cauna (1956).[5]

The core of the Meissner's corpuscle receives its nerve supply from the deep corial nerve plexus. The nerve bundles ascend obliquely or in wavy fashion and supply a single Mc or may divide and supply 2 to 3 Mcs. The number of Myelinated nerve fibers entering each corpuscle is 2 to 6, although Cauna (1956),[5] reported 2 to 9, Castano et al (1995),[10] 2-5 and Olle Johansson (1999)[12] reported 1-6 nerve fibers entering each Mc. Inside the core, the nerve fibers lose myelin and the unmyelinated nerve fibers branch and form ascending spirals. The nerve spirals are sandwiched between transversely arranged flattened lamellar cells (Schwann cells). Inside the core, the nerve fibers form complicated endings like neurofibrillar networks, closed end bulbs and nerve thickenings or varicosities (Figure 4). In between the nerve fibers and lamellar cells, there is a fine network of collagen fibers. Tachibana (1995),[13] stained collagen of Mc immunohistochemically and reported that collagen present in Mc is of type VI.

CONCLUSION

From the above we conclude that structurally Mc is a complex structure consisting of capsule of collagen fibers in which are interspersed fibrocyte variety of capsular cells and core formed of ascending spirals of nerve fibers, collagen fibers and lamellar cells. The nerve fibers inside the core are of three types: neuro-fibrillar networks, varicosities and end bulbs.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Iggo A., Andres KH (1982): Morphology of cutaneous receptors. Ann Rev Neurosc. 5: 1-31.
2. Bhat G M, Bhat M A, Kour K, Shah B A (2008): Density and structural variations of Meissners corpuscle at different sites in human glabrous skin.J. Anat. Soc. India 57 (1) 30-33.
3. Winkelmann RK, Schmit RW (1951): A simple silver method for nerve axoplasm. Proc. Staf Myoclinic. 32: 217-223.
4. Wagener R, Meissner G (1852) cited by Cauna N. (1956b) Nerve supply and nerve endings in Meissner's corpuscles. Am. J. Anat. 99:315-350.
5. Cauna N (1956 a): Structure and origin of the capsule of Meissner's corpuscle. Anat. Rec. 124:77-92.
6. Miller MR, Ralston HJ, Kasahara M (1958): The pattern of cutaneous innervation of the human hand. Am. J. Anat.102: 183-198
7. Cauna N, Ross LL (1960): The fine structure of Meissner's touch corpuscles of human finger. J. Biophysical and Bioch. Cytol.8 :467-482.
8. Dickens WN, Winkelmann RK, Mulder DW (1963): Cholinesterase demonstration of dermal nerve endings in patients with impaired sensation. Neurology Minneap.13: 91-100.
9. Hashimoto K (1973): Fine structure of the Meissner's Corpuscle of palmar skin. J. Investigative Dermatology. 60:189-208.
10. Castano P, Rumio C, Morini M, Miani A Jr, Castano SM (1995).Three Dimensional reconstruction of the Meissner's corpuscle of man after silver impregnation and Immuno-fluorescence with PGP 9.5 antibodies using Con-focal scanning laser microscopy. J. Anat. 186: 261-270.
11. Krause W (1881): Die nervenendigung innerhalb derterminalen Korperchen. Arch F Firk Anat. 19: 53-136.Cauna N. (1956 a): Structure and origin of the capsule of Meissner's corpuscle. Anat. Rec. 124:77-92.
12. Johansson O, Fontini F (1999): Neuronal structural proteins, transmitters, transmitter enzymes and neuropeptides in human meissner's corpuscles: A reappraisal using immuno-histochemistry. Arch Dermatol Res. 291: 419-424.
13. Tachibana T, Iida S, Nawa T. (1995): Type v1 collagen as a major component in the interstitial matrix of cutaneous mechanoreceptors. Arch Histol Cytol. 58(5): 507-515.

DOI: 10.5455/2320-6012.ijrms20131118
Cite this article as: Bhat GM, Shah NA, Itoo MS, Shah BA, Shahdad S, Khan JA. Structural organization and pattern of innervations of human Meissner's corpuscle: a light microscopic study. Int J Res Med Sci 2013;1:409-12.