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Differences in the microanatomy of skin of sole and palm in humans

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ABSTRACT

Background: The prevalence of skin diseases has increased over the last few decades and they contribute to a significant burden on the health-care systems all across the world. In some forms of reconstructive or plastic surgery, palm skin has successfully been replaced with sole skin, removed to form a full-thickness graft that covered almost the entire palm of the hand without impairing the weight-bearing areas of the feet or encumbering the gait. In cases such as these, the skin of the palm and sole is preferred for grafts. **Aims and Objectives:** The study was conducted to learn the microanatomy of palm and sole. **Materials and Methods:** The present observational study was carried out in the Department of Anatomy, King George Medical University, Lucknow, from the period of September 2017 to August 2018. Ethical clearance was obtained from Institutional Ethics Committee (Ref. code:63/Ethics/R-Cell-18). For the present study, skin was procured from the palm and sole of six freshly embalmed human cadavers (three males and three females). The mean age of the cadavers was 67 years. Tissues were preserved in 10% of formaldehyde for 48 h, fixed, Stained in H and E, and observed under light microscope. **Results:** The study showed that the thickness of epidermis and ratio of epidermis to stratum corneum (Edp: sc) of the sole are greater than palm, dermoepidermal junctions were more in sole. Thickness of dermis both papillary and reticular dermis was more in sole than palm. **Conclusion:** The values of thickness of skin of palm and sole region provide data for plastic surgeons to plan cosmetic surgeries.

Key words: Palm; Sole; Rete pegs; Dermal papillae

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INTRODUCTION

Skin is composed of the epidermis and dermis and is the outermost tissue of the human body. Epidermis consists of four layers (from deep to superficial): Basal layer, spinous layer, granular cell layer, and stratum corneum.[1] Glabrous skin consists a fifth layer (stratum lucidum) that is sometimes identified – between the stratum granulosum and stratum corneum layer. It is a thin transparent layer, difficult to recognize in routine histological sections.[2] Sometimes, there was no clear transition between the stratum lucidum and corneum.[3] Less studies comment on stratum lucidium. In the present study, also stratum Lucidium was unidentified.

The dermis involves cells, connective tissue, and ground substance and contains blood and lymphatic vessels, nerves, glands, and hair follicles. Dermis is divided into two layers as papillary dermis and reticular dermis.[1] Skin performs significant functions such as protection against external physical, chemical, and biologic assailants, as well as prevention of excess water loss from the body and a role in thermoregulation.[4] The thickness of each layer of the skin varies depending on body region and categorized based on the thickness of the epidermal and dermal layers.[5] Studies suggest the importance of skin biophysical properties in predicting diseases; hence, it helps to develop appropriate skin care. Palms and soles are visible areas of our body. They are affected in various dermatoses. Moreover, palmoplantar dermatoses also limit our day-to-day activities, and thereby have a significant impact on the quality of life. Palmoplantar psoriasis was the most common disorder affecting palms

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and soles.[6] According to research, psoriasis affects 2–5% of the total population, and 3–4% of individuals with psoriasis have palmoplantar psoriasis.[7] Another study suggests skin of palm and sole involved in diseases such as eczema and hyperkeratosis. These are more common in farmers and other workers involved in agriculture. It was observed that Hand and foot eczemas accounted for 9.1% and 12.40% for hyperkeratosis of palm and sole among the total cutaneous manifestations. This is possible because majority of the paddy field workers were found to remain in touch with dried husk and grains, fertilizers, sewage water, and other chemicals which can act as potential cutaneous allergens and irritants. Hence, it is suggested that role of occupation plays a significant role in causing and worsening hand and feet eczema in paddy field workers.[8]

Understanding the thickness of epidermis and dermis of skin can contribute the derma research. Not only dermatologist can get its benefit also the specialties can be benefitted. Study showed plantar skin grafting is a reliable alternative to anterior or posterior thigh skin grafting skin on the plantar aspect of the feet differs from skin on other parts of the body because it is glabrous skin, which has special attributes, including a thicker epidermis. In addition, it has abundant sweat glands and dermal papillae that allow rapid healing but fewer melanocytes and no sebaceous glands or hair follicles. These characteristics make plantar skin functionally and esthetically different from the skin found on the rest of the body but also provide some advantages for its use as an split thickness skin graft (STSG) to cover lower-leg wounds, especially considering that location of plantar skin is convenient for surgical preparation and that scarring can be concealed more easily.[9] Former studies stated about whole thickness of skin of palm and sole, the present study highlights thickness of components of skin (epidemins, papillary dermis and reticular dermis, commented on depth and numbers of rete pegs (rp), and layers of stratum corneum and stratum granulosum. Henceforth provides the detail data for researchers and medical experts for further exploration of these areas.

Aims and objectives

To learn the differences in microanatomy of skin of sole and palm in humans, including the layers of epidermis, dermis and dermo-epidermal junction.

MATERIALS AND METHODS

The present observational study was carried out in the Department of Anatomy, King George Medical University, Lucknow, from the period of September 2017 to August 2018. Ethical clearance was obtained from the Institutional Ethics Committee, King George Medical University, Lucknow, through (Ref. code:63/Ethics/R-Cell-18).

For the present study, skin was procured from the palm and sole of six freshly embalmed human cadavers. Out of these, three were males and three were females. Age of the male and female cadavers ranged between 60 and 70 years (mean age 67 years). Skin samples measuring 1 cm (L)×0.5 cm (B) were taken from center of palm and sole. Tissue was preserved in 10% of formaldehyde for 48 h.

Fixed tissue specimens were dehydrated through increasing concentrations (30%, 50%, 70%, 90%, and absolute) of ethanol. After clearing the tissue in xylene, embedding was done in paraffin wax. 5 μm thick sections were cut using rotary microtome. Whole thickness of tissue was sectioned. Three regions, each containing three sections were chosen at the interval of 20 sections. Thus, for each site of each cadaver, three slides were prepared. Hence, three slides were containing total nine sections of each tissue from each cadaver. Slides were stained by Haematoxylin (Harris's) and Eosin stain. Each stained section was observed for three different fields thus for each cadaver 27 observations were obtained.

Following eight quantitative parameters were observed for each slide;

1. Thickness of epidermis at dermal papilla (Edp)
2. Thickness of stratum corneum (Tsc)
3. Number of layers of stratum spinosum at dermal papilla (ss)
4. Number of layers of stratum granulosum at dermal papilla (sg)
5. Depth of rp (Drp)
6. Number of rp
7. Thickness of papillary dermis
8. Thickness of reticular dermis

The thickness of above-mentioned parameters was measured with the help of ERMA's micrometer. Value of each parameter in micrometer was entered into word excel sheet. For each parameter nine values were taken and the mean value was calculated. The values were represented in Number and Mean±SD. The mean value of each parameter was compared for gender-wise changes using student t-test and Mann–Whitney test. $P<0.01$ was considered highly significant. The statistical analysis was done using Statistical Package for the Social Sciences Version 21.0 Statistical Analysis Software. The microphotography was done with the help of device incorporated with software easy capture U S B 2.0 high-quality video and audio.

RESULTS

The study showed the thickness of epidermis and ratio of epidermis to stratum corneum (Edp:sc) of sole is greater than palm, that is, 714±15, 350±94, 0.70±0.16,

Table 1: Comparison of specimens from palm and sole region

Parameters of skin	Palm		Sole		Statistical significance	
	Mean (Median)	SD	Mean (Median)	SD	"t"	P-value
Thickness of epidermis (Edp)	350.533	94.06	714	155.18	−14.72	<0.001
Thickness of stratum corneum (sc)	221.10	120.89	477.39	38.35	−14.84	<0.001
Edp:sc	0.622	0.304	0.702	0.168	−1.67	<0.001
Layers of stratum spinoum (ss)*	3.44	1.0	2.96	0.77	2.63	<0.001
Layers of stratum granulosum (sg)*	2.67	0.89	2.33	0.97	1.8	0.531
Number of rete pegs	11.83	5.11	82.96	24.58	0.993	<0.001
Depth of rete pegs	150.16	48.92	82.96	24.58	9.01	<0.001
Thickness of papillary dermis	139.28	30.26	141.17	45.31	−.255	<0.001
Thickness of reticular dermis	434.68	95.3	850.48	132.81	−18.68	0.134

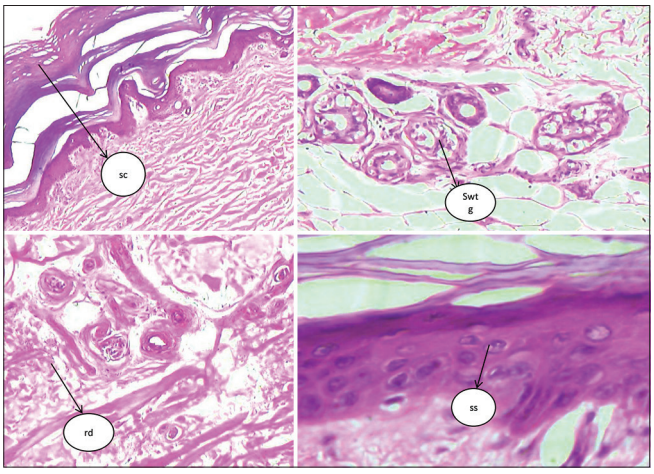


Figure 1: Stain: H and E microphotograph of sole showing sc, swt g, rd, and ss in ×4, ×10 and ×40, respectively

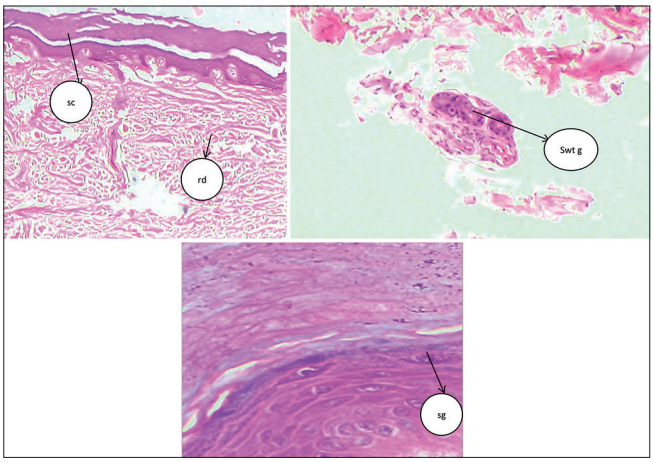
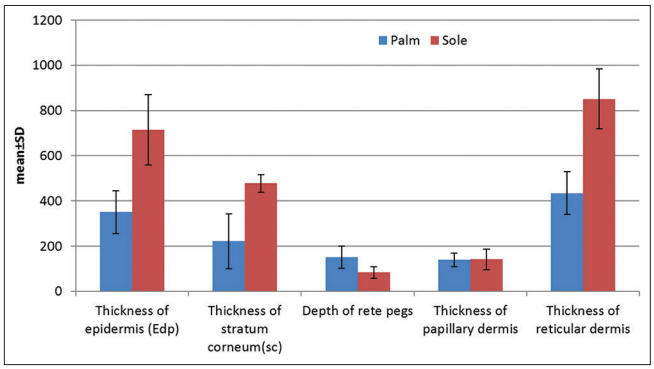


Figure 2: Stain: H and E microphotograph of palm showing sc, rd, swt g, and sg in ×4, ×10 and ×40, respectively

0.62±0.30, respectively. Thickness of stratum corneum is more in sole (477±38). Layers of stratum spinosum and stratum granulosum which are the components of epidermis are more in palm than sole (3.4±1.0, 2.9±0.7 and 2.6±0.8, 2.3±0.9, respectively. It suggests that thickness of epidermis of sole is more as other numerous studies suggest the same but the layers of epidermis can show the variation. Dermoepidermal junctions (number of rp) were more in sole than palm and were statistically significant, that is, 82.96±24.5, 11.83±5.1, respectively. It was observed that number is more in sole as compare to palm whereas rp were found more deeper in palm as comparison to number of its rp. Drp of palm (150±48) and sole (82.96±24.5) were found. Similarly, the thickness of dermis both papillary and reticular dermis was more in sole than palm (141.17±45, 850.4±13, 139.28±30, 434.6±95), respectively (Table 1).



DISCUSSION

Several studies have reported that human epidermis, dermis, and total skin thicknesses (ST) vary according to different body region, gender, age, and ethnic origin.[10] The characteristics of skin differ vastly in topology, pH, temperature, moisture, and microbiology at different body sites.[10] Hence, it is important to know the normal values of dermis, epidermis for some drug and vaccine research, skin-related clinical investigations, and skin transfer operations used in plastic surgery.[10] Thickness data may be useful in harvesting full or STSGs. Few authors reported the skin thickness of different regions of the body, but no detailed study have been performed on Asian.[11] The present study showed the thickness of skin of sole more than palm. The thickness of stratum corneum definitively plays a significant role contributing the thickness of epidermis of skin, as it was found more in sole than palm. Furthermore, Edp:sc, ratio of thickness of epidermis (consisting all its layers) to the thickness of stratum corneum found more in sole

than palm. As the layers of stratum spinosum (ss) and stratum granulosum were obtained more in palm than sole, proving the fact that stratum corneum could be responsible factor deciding the thickness of skin. Lee and Hwang also found epidermis of palm and sole thick, that is, 601–637 micron. The present study highlighted components of skin separately. Thickness of epidermis ranges 350±94, 714±15, thickness of stratum corneum (221±±12, 477±38), papillary dermis (139.28±30, 141±45), and reticular dermis (434±95, 850±13) for palm and sole, respectively.[11]

Dermoepidermal junction DEJ zone joins epidermis to dermis.

The DEJ formation commences at 10 weeks of post-fertilization when small undulations of the basal laminae appear, and dermal ridges begin to form as a result of cell proliferation within the basal layer of the epidermis.[12] DEJ consists primarily of laminins, collagen IV, nidogens, and the heparan sulfate proteoglycan perlecan, all of which are necessary for tissue organization and structural integrity.[13] None of the study commented on the DEJ of sole and palm. The present study showed the number and Drp were more in sole than palm.

The dermis comprises two structurally different layers named the papillary and reticular layer. The papillary layer, which is located closer to the skin surface, reaches a width of 300–400 microns, depending on the age and location. Papillary dermis differs from the reticular by a higher density of cells, a higher content of proteoglycans, and a weaker alignment of collagen fibers.[14] Our study founded the dermis of sole higher the palm, among them reticular dermis was observed thicker than papillary dermis; hence, suggesting reticular plays crucial role in deciding the dermal layer of skin.

Limitations of the study

Future researchers can increase the sample size and observed the values and may also comments on the other cellular layers of skin.

CONCLUSION

The higher number of layers of stratum spinosum resulted in grater thickness of epidermis in sole. In sole greater number of rp as compare to palm could have been responsible for contributing more basal keratinocytes and hence greater thickness of the epidermis. Knowing the values of thickness of skin of palm and sole region provides data for plastic surgeons to plan cosmetic surgeries. The present study commented on various thickness of skin, further area of layers of cells needs more detail investigation.

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KD- Review of literature, sample collection, preparation of slide, microscopy, histological analysis, data collection, data analysis, manuscript preparation, and submission of article; **AKP-** Study design, reviewer, microscopy, data analysis, data collection, manuscript preparation, and submission of article; **AnR-** Review of literature, study design, microscopy, and histological analysis; **JC-** Reviewer, study design, microscopy, data analysis, data collection, and manuscript preparation; **ArR-** Study design, reviewer, and data analysis; **PKB-** Study design, data analysis, and reviewer; and **PM-** Study design, reviewer, and data analysis.

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