https://doi.org/10.46351/jas.v32i1pp01-10

JAS Journal of Anatomical Sciences (U.P. Chapter of Anatomical Society of India)

Original Article

HISTOMORPHOMETRIC ANALYSIS OF SUN EXPOSED AND NON- SUN EXPOSED AREA OF HUMAN SKIN

Anjali Sharan[1], Swati Saxena[1], Jolly Agarwal[1], Mahendra Kumar Pant[1]

1. Department of Anatomy, Government Doon Medical College, Dehradun, India

ABSTRACT

Introduction: Knowledge of basic elements gives a clear vision of the structure of any organ. Skin is continuously being exposed to various external environmental factors, one of them is sun induced UV radiation, major environmental factor that affects the structure and function of human skin. On excessive exposure, UV radiation can cause premature aging and even skin cancer. Histological analysis of the variations among sun exposed and non-sun exposed human skin is of relevance in dermatologic research and dermatopharmacokinetics.

Materials and Methods: This study was conducted on 10 male and 10 female human cadavers. The rectangle shaped skin specimen (1 cm × 1 cm) was taken from two sites sun exposed (forehead) and non sun exposed (lower abdomen) and stained with hematoxylin and eosin stain. A total of 40 slides were prepared. Readings were obtained with the help of cellSens /OLYMPUS Stream software, using UIS2 (Universal Infinity System) optical design camera fitted in the light microscope.

Results: There were statistically significant differences among sun exposed and non-sun exposed area was found in epidermis (p=0.008 & r=0.754), no. of rete pegs (p=0.05 & r=0.573), no. of hair follicles (p=0.04 & r=0.565) and depth of rete pegs (p=0.03 & r=0.102).

Conclusions: The mean value of epithelium of sun exposed site is marginally thicker than non-sun exposed sites. The number of rete pegs per field was higher in exposed site as compared to non-sun exposed site.

Keywords: **D**ermatopharmacokinetics, Skin, Histomorphometry

Address for Correspondence:
Dr. Swati Saxena, Assistant Professor, Department of Anatomy, Government Doon Medical College, Dehradun, India
Email: 21swatidocsaxena@gmail.com Mob: 7880989023

Date of Receiving: 24 Nov 2023
Date of Acceptance: 12 Jan 2024

INTRODUCTION

Knowledge of basic elements gives a clear vision of the structure of any organ. Researches emphasized that the skin is irregular undulating structures, especially the epidermis. Its depth is an important determinant of percutaneous absorption of ultraviolet rays as stratum corneum acts as rate limiting barrier. Therefore, thickness of different layers of skin is helpful in evaluating, ultraviolet radiation induced carcinogenesis and aging [1-3].

Skin, is composed of the epidermis and the dermis, is the outermost tissue of the human body. The epidermis consists of four layers (from deep to superficial): basal layer, spinous layer, granular cell layer, and stratum corneum, whereas the dermis involves cells, connective tissue and ground substance and consists of blood and lymphatic vessels, nerves, glands, and hair follicles. The dermis is divided into two layers as the papillary dermis and the reticular dermis. There is a variable amount of subcutaneous fatty tissue beneath the skin [1,4].

Skin is continuously being exposed to various external environmental factors, one of them is sun induced UV radiation, major environmental factor that affects the structure and function of human skin. UV radiation has been known to cause skin cancer and premature aging on excessive exposure.

Solar UV radiation reaching the earth is a combination of UVB (290–320 nm) and UVA (320–400 nm) wavelengths [5]. It is now proved that UVA radiation plays a major role for the damaging effects of solar radiations. In fact, UVA radiation is the most prevalent component as it penetrates deeper than UVB radiation into the skin and induces profound alterations of the dermal connective tissue [1]. The consequences of UVA exposure on skin are particularly important in Asia because of the low latitude. It is also responsible for the early appearance of signs of photoaging, which include pigmentation, wrinkling, laxity, sagging, dryness, etc. One of the major detrimental effects of UVA radiation is the generation of oxidative stress which is a well-known factor in the photoaging pathogenesis [5-6].

Histological analysis of the variations among sun exposed and non-sun exposed human skin is of relevance in dermatologic research and dermatopharmacokinetics [4]. The aim of this study was to compare the microscopic anatomy of sun exposed (face) and non-sun exposed (lower abdomen) sites of human skin.

Objectives:

1. To measure the total skin thickness.
2. To measure the thickness of epidermis and its various layers

3. To measure the thickness of papillary and reticular layer of dermis.
4. To observe number and pattern of rete pegs at dermo-epidermal junction.
5. To estimate the distribution of hair follicles, sebaceous glands and sweat gland in dermis

MATERIALS AND METHODS

Study type: Observational study.

The present study was done in Department of anatomy, Government Doon Medical College, Dehradun (Uttarakhand) on 10 human male and 10 human female cadavers which were procured from donated body received in the department of anatomy within, 4 to 5 hours after death. The age of both the genders was ranged between 25- 70 years (mean age 47.5). The ethical clearance was obtained from the Ethics Committee, Government Doon Medical College, Dehradun.

Inclusion criteria: Samples were taken from sun exposed and non-sun exposed area of skin from the fresh corpses arrives at GDMC in anatomy department, within 48 hours of death. They were residents of Dehradun.

Exclusion criteria: Cadavers and deceased residing outside Dehradun and beyond 48 hours were not included in the study. The area of skin present with abrasion, infections, breech such as boils, crusting were excluded.

Tissue processing and staining: Full-thickness skin biopsy specimens were taken using scalpels measuring 1 cm × 1 cm. The biopsy specimens were taken from two sites, sun exposed (forehead) and non-sun exposed (right iliac fossa). The specimens were preserved in formalin, processed, sectioned and stained with haematoxylin and eosin stain and mounted on slides. Skin thickness measurements were performed under light microscopy using 10x and 4x magnification.

Parameters were individually determined per slide and were then averaged to a single data set to prevent errors. Each of the slide contained horizontal sections of tissue. Parameters such as epithelium thickness, depth, number, and number of rete pegs at the dermoepidermal junction,

Thickness of dermis were taken in 4x except thickness of stratum corneum (Tsc) and epidermal thickness which was taken at 10x. Readings of the above-mentioned parameters were analysed by cellSens/OLYMPUS Stream software, using UIS2 (Universal Infinity System) optical design camera fitted in the light microscope.

Statical analysis: All data were tabulated in Microsoft excel sheet and statically analyzed. Findings were expressed in mean and standard deviation.

RESULTS

The mean value of stratum corneum, epidermis, papillary dermis and total skin thickness were found to be more in sun exposed area whereas, thickness of reticular dermis and total dermis was more in non-sun exposed area. Number of rete pegs and depth of rete pegs were higher at the exposed site along with number of sweat glands and hair follicles.

Statistically significant differences among sun exposed and non-sun exposed area was found in epidermis (p=0.008 & r=0.754), no. of rete pegs (p=0.05 & r=0.573), no. of hair follicles (p=0.04 & r=0.565) and depth of rete pegs (p=0.03 & r=0.102).

S.NO.	PARAMETERS (µm)	SUN EXPOSED SITE (MEAN ± STD.DEV)	NON SUN EXPOSED SITE (MEAN ± STD.DEV)	t-TEST (p- value)	CO-RELATION
1	STRATUM CORNEUM	94.12 ± 51.67	6.63 ± 6.84	0.059	0.131
2	EPIDERMIS	107.65 ± 66.08	58.02 ± 39.39	0.008	0.754
3	PAPILLARY DERMIS	70.54 ± 34.13	49.80 ± 48.63	0.119	0.331
4	RETICULAR DERMIS	1180.45 ± 105.18	1355.69 ± 140.08	0.383	0.048
5	DERMIS	1251 ± 98.25	1405.50 ± 159.98	0.395	0.092

Table 1(a). Comparison of different parameters of sun exposed and non sun exposed area of human. skin

S.NO.	PARAMETERS	SUN EXPOSED SITE (MEAN ± STD.DEV)	SUN NON- EXPOSED SITE (MEAN ± STD.DEV)	t-TEST (p- value)	CO-RELATION
1	TOTAL SKIN THICKNES	1358.65 ± 97.64	1463.52 ± 147.11	0.427	0.109
2	NO. OF RETE PEGS	11.4 ± 5.85	6.5 ± 3.95	0.0541	0.573
3	NO. OF HAIR FOLLICLES	4.5 ± 3.32	2.4 ± 2.28	0.049	0.565
4	NO. OF SWEAT GLANDS	13.2 ± 12.01	8.5 ± 5.67	0.311	0.165
5	DEPTH OF RETE PEGS	144.7 ± 77.55	69.36 ± 19.73	0.0378	0.102

Table 1(b). Comparison of different parameters of sun exposed and non sun exposed area of human skin.

Fig. 1. Histological image showing showing papillary dermis, reticular dermis, rete pegs, sebaceous gland, sweat gland and hair follicle in non-sun exposed area at 4X

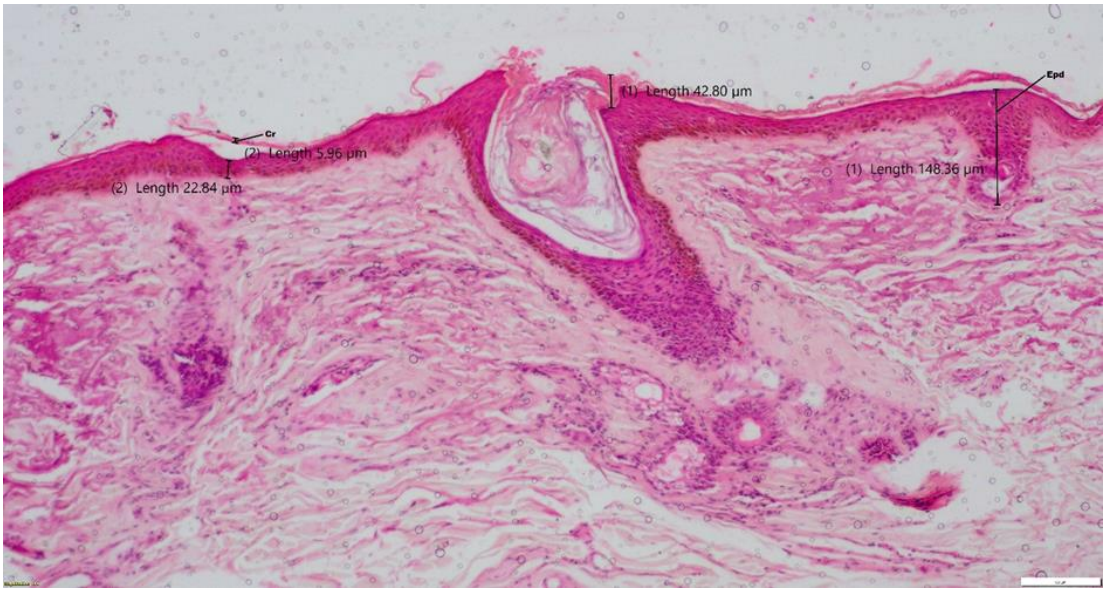

Fig. 2. Histological image showing stratum corneum and epidermis of non- sun exposed area at 10x

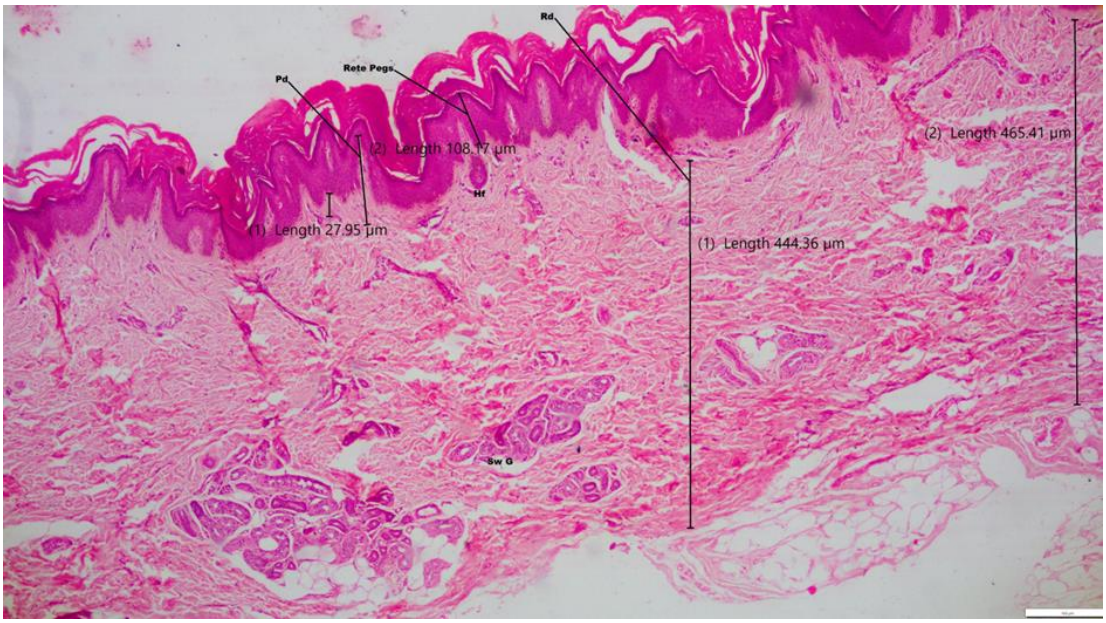

Fig. 3. Histological image showing papillary dermis, reticular dermis, rete pegs, sebaceous gland, sweat gland and hair follicle in sun exposed area at 4X

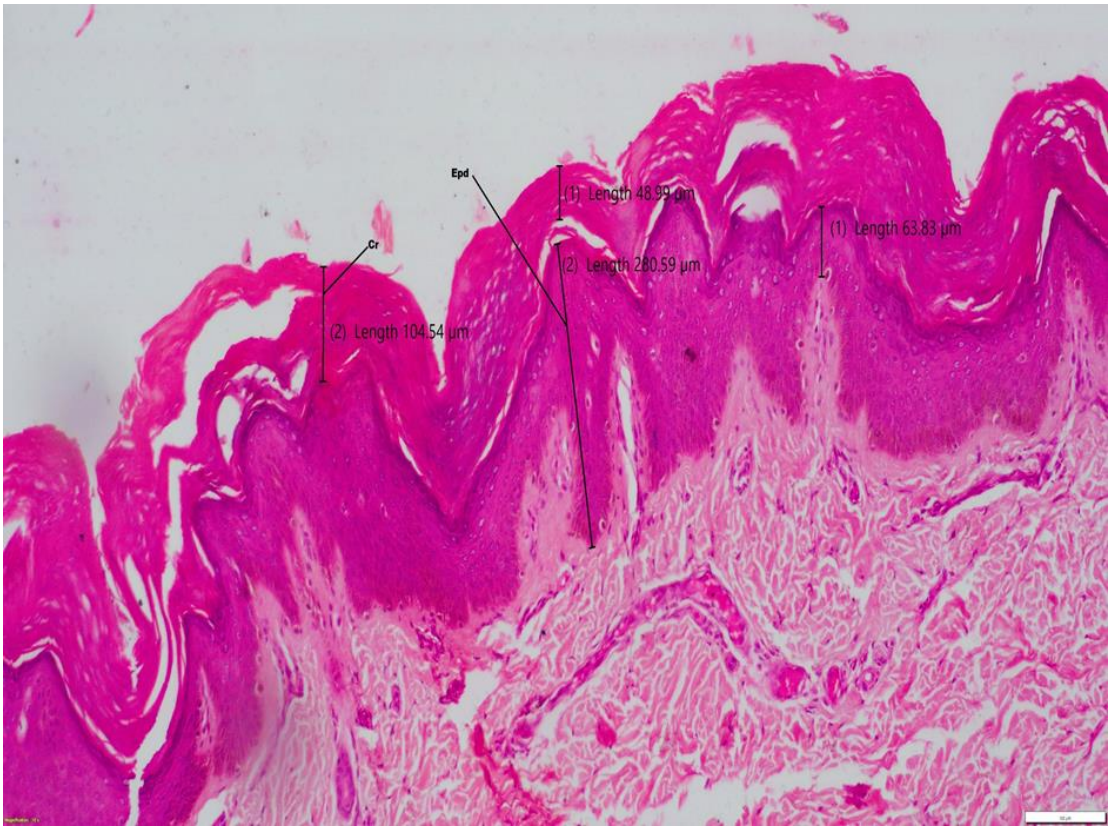

Fig. 2. Histological image showing stratum corneum and epidermis of non- sun exposed area at 10x

DISCUSSION

Histologic analysis of the normal skin is of relevance in dermatological research. Knowledge about the normal values of dermis, epidermis, or total ST is essential for various drug and vaccine research, skin related clinical investigations, and skin transfer plastic surgeries. Pembe Oltulu et al in 2022 observed that the thickness of epidermis, dermis and total skin thickness of dorsum of hand was found to be 244.8±92.9µm, 2538.5±13µm and 2284±14µm respectively in below 50 years age group whereas, thickness of epidermis, dermis and total skin thickness of abdominal skin was 163.3±44.5µm, 5497.7±17µm and 5661±18µm respectively. Data was found to be nearly similar with the finding of our study except the dermal and total skin thickness of abdomen which was found to be higher in our study.[14] whereas, dermis and total skin thickness was similar with the study of Chopra et al [12]. Number of hair follicles, rete pegs, sweat glands and depth of rete pegs were found to be variable with other studies.

S.NO.	AUTHOR'S NAME	YEAR	N	STRATUM CORNEUM		EPIDERMIS	
				EXP.	NON-EXP.	EXP.	NON-EXP.
1	Freemann et al.[7]	1962	28	16	28	67	95
2	Hoffmann et al.[8]	1994	40	2.23±0.23	1.80±0.32	_	_
3	Lavker et al. (mm) [5]	1995	23	15.0±0.7	8.1±0.7	81.5±2.5	76.0±0.3
4	Huzaira et al.[9]	2001	10	13.66±29	8.08±1.8	_	_
5	Sandby-Moller et al.[10]	2003	76	18.3±49	14.9±3.4	74.9±12.7	96.5±16.1
6	Robertson et al.[11]	2010	25	9.3	6.3	62.5	61.5
7	Chopra et al.[12]	2015	10	_	_	44.70±13.99	_
8	Khiao et al.[13]	2019	11	6.6±0.5	13.2±2.3	51.6±3.5	59.9±8.5
9	Saxena et al.[4]	2022	10	14.21±4.69	_	86.72±31.49	_
10	Oltulu et al.[14]	2022	180	224.8±92.9	163.3±44.5	_	_
11	Jeong et al. (mm) [15]	2023	99	_	_	0.334±0.157	_
12	Present study	2023	10	94.12± 51.67	6.63±6.84	107.65±66.08	58.02±39.39

Table (2a). Showing difference between stratum corneum and epidermis thickness of sun exposed and non sun exposed skin

S.NO.	AUTHOR'S NAME	YEAR	N	DERMIS		TOTAL SKIN THICKNESS	
				EXP.	NON-EXP.	EXP.	NON-EXP.
1	Chopra et al.[12]	2015	10	1200.93±297.23	_	1245.63	_
2	Khiao et al.[13]	2019	11	952.4±127.0	1831.5±29.6	_	_
3	Saxena et al.[4]	2022	10	578±296.76	_	664.72±293.11	_
4	Oltulu et al.[14]	2022	180	2538.5±1373.9	5497.7±1722.2	2284±1407	5661±1733.2
5	Jeong et al. (mm) [15]	2023	99	1.019±0.534	_	1.353±0.57	_
6	Present study	2023	10	1251±98.25	1405.50±159.58	1358.65±97.64	1463.52±147.11

Table (2b). Showing difference between dermis and total skin thickness of sun exposed and non sun exposed skin

S.NO.	AUTHOR'S NAME	YEAR	N	NO. OF HAIR FOLLICLE		NO. OF RETE PEGS		NO. OF SWEAT GLANDS		DEPTH OF RETE PEGS	
				EXP.	NON-EXP.	EXP.	NON-EXP.	EXP.	NON-EXP	EXP.	NON-EXP.
1	Huzaira et al.[9]	2001	10	_	_	_	_	_	_	130.25±10.55	110.58±8.87
2	Robertson et al.[11]	2010	25	_	_	_	_	_	_	39.6	50.8
3	Khiao et al.[13]	2019	11	30.7±4.3	7.0±3.3	_	_	30.8±8.1	15.7±1.1	1131.2±39.9	1419.5±46.7
4	Saxena et al.[4]	2022	10	_	_	7.10±0.80	_	_	_	225.60±126.32	_
5	Present study	2023	10	4.5±3.32	2.4±2.28	11.4±5.85	6.5±3.95	13.2±12.01	8.5±5.67	144.7±77.55	69.36± 19.73

Table (2c). Showing no. of hair follicles, no. of rete pegs, no. of sweat glands and depth of rete pegs in various studies

CONCLUSION

The present observational study was undertaken to assess the difference between sun exposed and non-sun exposed sites of human skin histologically. The mean value of epithelium of sun exposed site is marginally thicker than non-sun exposed sites. The number of rete pegs per field was higher in exposed site as compared to non-sun exposed site.

This study tried to create a baseline comparison to establish the presence of histological variations caused by UV radiations which is different from chronological changes. The measurement of skin thickness, stratum corneum, dermal thickness can also prove useful in plastic surgery.

REFERENCES

1. Standring S, editor. Gray's anatomy e-book: the anatomical basis of clinical practice. Elsevier Health Sciences; 2021 May 22.
2. Young B, O'Dowd G, Woodford P. Wheater's functional histology e-book: a text and colour atlas. Elsevier Health Sciences; 2013 Oct 9.
3. Battie C, Jitsukawa S, Bernerd F, Del Bino S, Marionnet C, Verschoore M. New insights in photoaging, UVA induced damage and skin types. Exp Dermatol. 2014 Oct;23:7-12.
4. Saxena S, Pankaj AK, Panwar S, Rani A, Chopra J, Rani A. Gender-wise histological differences in the human upper lip. Acta Medica Int. 2022 Jan 1;9(1):1.
5. Lavker RM, Gerberick GF, Veres D, Irwin CJ, Kaidbey KH. Cumulative effects from repeated exposures to suberythemal doses of UVB and UVA in human skin. J Am Acad Dermatol. 1995 Jan;32(1):53-62.
6. Contet-Audonneau JL, Jeanmaire C, Pauly G. A histological study of human wrinkle structures: comparison between sun-exposed areas of the face, with or without wrinkles, and sun-protected areas. Br J Dermatol. 1999 Jun;140(6):1038-47.
7. Freeman RG, Cockerell EG, Armstrong J, Knox JM. Sunlight as a factor influencing the thickness of epidermis. J Invest Dermatol. 1962 Oct;39(4):295-8.
8. Hoffmann K, Stuücker M, Dirschka T, Goörtz S, El-Gammal S, Dirting K, Hoffmann A, Altmeyer P. Twenty MHz B-scan sonography for visualization and skin thickness measurement of human skin. J Eur Acad Dermatol Venereol. 1994 Aug;3(3):302-13.
9. Huzaira M, Rius F, Rajadhyaksha M, Anderson RR, González S. Topographic variations in normal skin, as viewed by in vivo reflectance confocal microscopy. J Invest Dermatol. 2001 Jun;116(6):846-52.
10. Sandby-Møller J, Poulsen T, Wulf HC. Epidermal thickness at different body sites: relationship to age, gender, pigmentation, blood content, skin type and smoking habits. Acta Derm Venereol. 2003 Dec 24;83(6):410-3.
11. Robertson K, Rees JL. Variation in epidermal morphology in human skin at different body sites as measured by reflectance confocal microscopy. Acta Derm Venereol. 2010 May 24;90(4):368-73.
12. Chopra K, Calva D, Sosin M, Tadisina KK, Banda A, De La Cruz C, Chaudhry MR, Legesse T, Drachenberg CB, Manson PN, Christy MR. A comprehensive examination of topographic thickness of skin in the human face. Aesthet Surg J. 2015 Nov 1;35(8):1007-13.
13. Khiao In M, Richardson KC, Loewa A, Hedtrich S, Kaessmeyer S, Plendl J. Histological and functional comparisons

of four anatomical regions of porcine skin with human abdominal skin. Anat Histol Embryol. 2019 May;48(3):207-17.

14. Oltulu P, Ince B, Kokbudak N, Findik S, Kilinc F. Measurement of epidermis, dermis, and total skin thicknesses from six different body regions with a new ethical histometric technique. Turk J Plast Surg. 2018 Apr 1;26(2):56-61.
15. 15. Jeong KM, Seo JY, Kim A, Kim YC, Baek YS, Oh CH, Jeon J. Ultrasonographic analysis of facial skin thickness in relation to age, site, sex, and body mass index. Skin Res Technol. 2023 Aug;29(8).