ORIGINAL ARTICLE

Indian Journal of Forensic Medicine and Pathology
Volume 16, Number 2, April-June 2023
DOI: https://dx.doi.org/10.21088/ijfmp.0974.3383.16223.3

Histopathological Features of Skin changes caused by Electrocution: An Autopsy study

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How to cite this article:
Divya Lakshmi P.K, Vinodini S, Saranya S/Histopathological Features of Skin changes caused by Electrocution: An Autopsy study. Indian J Forensic Med Pathol.2023;16(2):109-114.

ABSTRACT

Background: Dependency to electrical equipments and improper safety measures has led to a significant increase in deaths due to electrocution. Confirming the cause of death in electrocution is one of the biggest challenges. Skin is the most frequently involved tissue in electrocution and histopathology of skin from electric marks aids in proper diagnosis.

Objectives: To study the histomorphological features of epidermis and dermis in skin tissue of entry and exit wounds in electrocution deaths.

Material and Methods: This is an observational study done over a period of one year. Skin biopsy from medico legal autopsy of non-lightening electrocution deaths obtained from entry or exit wound site were included for the study. Gross and histopathological details were studied and data analyzed.

Results: Significant gross features were surface discoloration of skin 16 (61%) and ulceration 05 (20%). Microscopic features were coagulative necrosis 21 (80.7%), dermo-epidermal separation 20 (80.7%), focal ulceration of epithelium 05 (19%), clefting of epidermis (60%), streaming of nuclei (92.3%), elongation of nuclei (92.3%) and microblisters 02 (15.3%).

Conclusion: One of the important causes of negative autopsy is electrocution deaths. In such cases dermatopathology is a diagnostic tool coupled with circumstantial evidence. Histological hallmark of electrocution skin injury is epidermal nuclear elongation.

Keywords: Electrocution; Skin biopsy; Histopathology; Autopsy; Skin changes.

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Received on: *25.01.2023* ***Accepted on:*** *01.04.2023*

INTRODUCTION

Electrocution is the passage of a substantial electrical current through the tissue, which can cause skin lesions, organ damage and death.[1,2] Dependency to electrical equipments and improper safety measures has led to a significant increase in deaths due to electrocution. Electrocution is

one of the major health problems associated with high mortality. A very minimal amount of electric current required to lit a bulb of 7.5W, 120 volt lamp is enough to cause electrocution.[3] Electric injury and death are common in both industrial and domestic circumstances.[4] Among them most of the deaths are due to low voltage current in domestic and industrial settings.

Confirming the cause of death in electrocution is one of the biggest challenges faced by Forensic Pathologist.[2] Internal autopsy findings are often inconclusive.[5] Electrical injuries leave no visible scar or a minimal scar on the skin. Hence there is a need for histopathological study of skin changes in electrical injury to support the allegations to electrical torture.[6]

Skin is a thin layer of tissue but highly resistant to the passage of electric current. Skin resistance to electric current is not homogenous throughout the body. Insulation is poor at certain sites. The resistance of the normal skin can be lowered by moisture/wet. Flow of electrical current is roughly proportional to water. Electric mark is caused by electric current at the site of contact with electricity. The external signs of electrocution injury include the entry and the exit wounds. Skin is the most frequently involved tissue. Only the autopsy findings of electric marks on the skin are often confused with impact abrasion. Hence microscopic findings coupled with proper inspection of crime site will help to arrive at the diagnosis of electrocution deaths.[3]

The present study aims to study the histopathological features of epidermis and dermis in skin tissue of entry and exit wounds in electrocution deaths.

MATERIALS AND METHODS

This is an observational study done over a period of one year in a tertiary care center, Davangere district. Skin specimens from both entry and exit wounds were received in the department of pathology in 10% formalin for histopathological examination. After adequate fixation skin samples were examined for gross changes and biopsies were processed in the routine manner and slides were stained with Haematoxylin and Eosin. Relevant history was obtained from Forensic histopathology request form. Detailed microscopic study was done. Histopathological changes from both epidermis and dermis of both exit and entry wound of electrocution deaths were evaluated.

Inclusion criteria: Skin samples from medico-legal autopsies of non-lightening electrocution deaths.

Exclusion criteria: Thermal and lightening electrocution deaths.

OBSERVATION AND RESULTS

Twenty-five electrocution deaths were autopsied by Forensic Medicine, in which 13 (52%) cases required definitive diagnosis. We received 26 skin samples from both entry (N=13) and exit (N=13) wound site.

Table 1: Showing age wise distribution of electrocution deaths

Age group	Age	Sex	
	Total number	No of females	No of males
	N=13	N=2	N=11
0-20 years	01	0	01
21-40 years	11	2	09
>41 years	01	0	01

The study comprised of 26 skin samples from both entry and exit wound site of non-lightening deaths due to electrocution. There were 11 males and 02 females. The youngest patient was 4 years male and eldest patient was 58 years male.

Table 2: Site of lesion

Site	Entry wound N=13	Percentage (%)	Exit wound N=13	Percentage (%)
Upper extremity	13	100	02	15
Lower extremity	0	0	11	85
Both	0	0	0	0

Entry wound involving upper extremity were seen in 13 (100%) of cases. Exit wound involving upper extremity were seen in 2 (15%) of cases and lower extremity in 11 (85%) of cases.

Table 3: Macroscopic appearance of skin

Gross appearance	No. of skin samples		
	Entry wound N=13	Exit wound N=13	Both N=26
1.Surface discoloration	09	07	16(61%)
2.Ulceration	03	02	05(20%)

The skin samples were of an average size ranged between 0.3 to 8 cms. Among 13 (100%) entry wound site 09 (69.2%) skin samples showed surface discoloration and 3 (23.1%) showed ulceration. In exit wound 7 (53.8%) skin samples showed surface discoloration and 2 (15.6%) showed ulceration.

Fig. 1: Entry wound

Fig. 2: Exit wound

Table 4: Microscopic changes in epidermis and dermis

Sl. No	Microscopic changes in Epidermis and Dermis	Entry wound N=13	Percentage (%)	Exit wound N=13	Percentage (%)	Both N=26	Percentage (%)
1	Coagulative Necrosis	11	84.6	10	76.9	21	80.7
2	Clefting of Epidermis	9	69.2	8	61.5	17	65.3
3	Haemorrhage	7	53.8	5	38.4	12	46
4	Dermo-epidermal separation	11	84.6	9	76.9	20	80.7

table cont.....

5	Streaming of nuclei	12	92.3	12	92.3	24	92.3
6	Elongation of nuclei	12	92.3	12	92.3	24	92.3
7	Ulceration	3	23	2	15.3	5	19
8	Microblisters	2	15.3	0	0	2	15.3

Out of 26 skin samples 13 skin samples were from entry wound and 13 samples were from exit wound. Haematoxylin and Eosin stained sections were studied in detail to note the changes in all the layers of the skin. The microscopic evaluation of both entries wound and exit wound revealed following changes.

In entry wound coagulative necrosis were seen in 11 (84.6%) of skin samples, clefting of epidermis were seen in 09 (69.2%) of skin samples, haemorrhage in 07 (53.8%) of skin samples, dermo-epidermal separation was seen in 11 (84.6%) of skin samples, streaming of nuclei in 12 (92.3%) of skin samples, elongation of nuclei in 12 (92.3%) of skin samples, ulceration in 3 (23%) of skin samples and microblisters were seen in 02 (15.3%) of skin samples.

In exit wound coagulative necrosis were seen in 10 (76.9%) of skin samples, clefting of epidermis were seen in 09 (61.5%) of skin samples, haemorrhage in 05 (38.4%) of skin samples, dermo-epidermal separation was seen in 09 (76.9%) of skin samples, streaming of nuclei in 12 (92.3%) of skin samples, elongation of nuclei in 12 (92.3%) of skin samples, ulceration in 02 (15.3%) of skin samples and microblisters were not observed in any of exit wound skin samples.

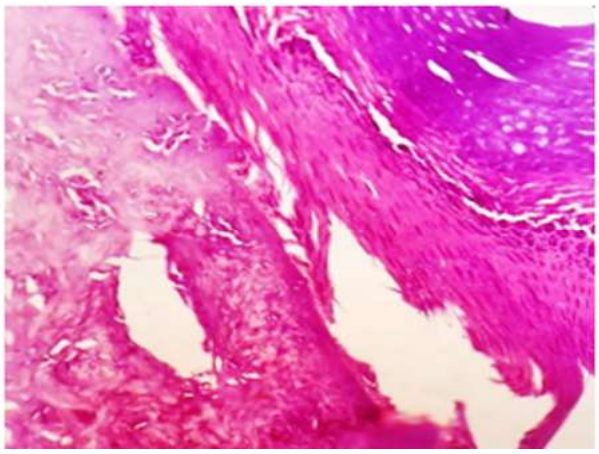

Fig. 3: Streaming and elongation of nuclei and dermo-epidermal separation

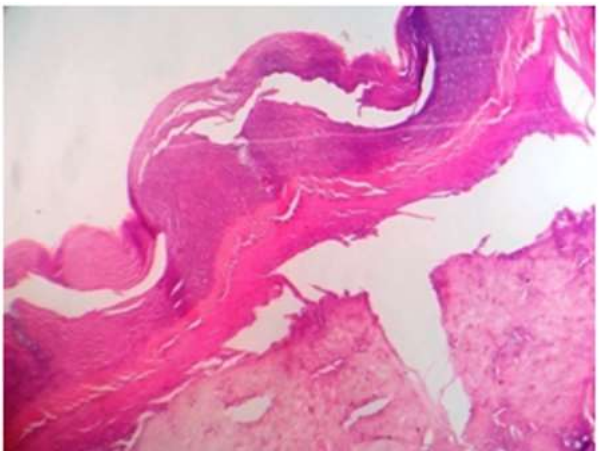

Fig. 4 (A & B): Dermo-Epidermal separation

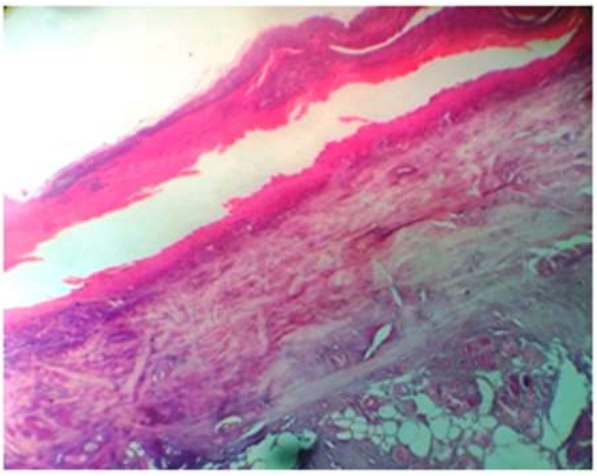

Fig. 5: Clefting of epidermis

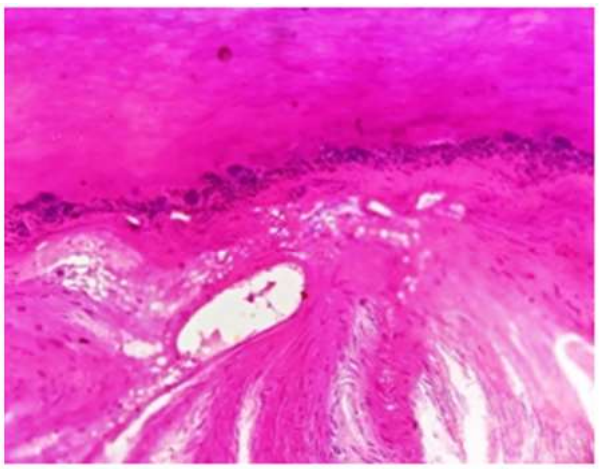

Fig. 6: Microblisters and streaming of nuclei

By various studies	Coagulative Necrosis (%)	Clefting of epidermis (%)	Dermo-Epidermal separation (%)	Streaming of nuclei (%)	Elongation of nuclei (%)	Ulceration of epithelium (%)	Microblister formation (%)
Sangeta C et al[5]	100	100	96	100	100	0	0
Patil RN et al[3]	89	96	96	96	96	0	7
Uzun I et al[7]	46.7	73.3	83.3	93	73.3	0	0
Present study	80.7	65.3	80.7	92.3	92.3	19	15.3

Discussion

Histopathology of skin changes plays an important role in determining electrocution as a cause of death in medico-legal diagnosis.[8,9] The present study was undertaken to evaluate the histopathological findings of skin changes caused by electrocution injury. All the skin samples were evaluated carefully under light microscope to observe for the following changes in epidermis and dermis. The important histological features observed in these skin samples were viz., coagulative necrosis, clefting of epidermis, haemorrhage, dermo-epidermal separation, streaming of nuclei, elongation of nuclei, ulceration and microblisters. In the present study we found that the above mentioned histopathological features will helps in diagnosing electrocution injury.

Microscopic examination of skin samples of both entry and exit wounds showed characteristic nuclear elongation and streaming in the epidermis mainly of basal layer. Epidermal nuclear elongation and streaming is one of the most important feature of electrocution injury. Elongated and pyknotic nuclei causes streaming of nuclei which give rise to palisading effect which is important feature of electrocution injury.[10] In Previous studies it was reported that streaming and elongation of nuclei are caused by polarization effect of current. Takamiya M *et al* reported that epidermal nuclear elongation is due to expansion of dermis due to heat.[11] Thomsen HK *et al* reported elongation of nuclei is seen only in electrical injury whereas in flame burn injury nuclei are unaffected.[12] Uzun et al. done a comparative study between electrical injury, abrasions and flame burns and concluded that nuclear features are seen in all three types of lesions but relatively in lower proportion compared to other types of injuries.[5]

In the present study nuclear elongation and nuclear streaming were almost observed in all 24 (92.3%) of skin samples. The observation is similar to the studies conducted by Sangeta C *et al*, Patil RN *et al* and Uzun I *et al*.

Epidermal separation is due to formation of microblisters that formed due to cooking effect of the skin tissue due to strong heat produced during electric shock. In the present study dermo-epidermal separation was seen 20 (80.7%) of skin samples, the observation is similar to the studies conducted by Sangeta C et al, Patil RN *et al* and Uzun I *et al*.[5,3,7] Coagulative necrosis was seen in 21 (80.7%) of skin samples.

Conclusion

- Electrocution is one of the major causes of negative autopsy.
- In such cases, dermatopathology is a diagnostic tool coupled with circumstantial evidence.
- Histological hallmark of electrocution of skin injury is epidermal nuclear elongation and streaming of nuclei.

Conflict of Interest: *Nil*

Source of Funding: *Nil*

Ethical clearance: *Nil*

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