ISSN: 2581 – 3633

International Journal of Medical Science and Advanced Clinical Research (IJMACR)

Available Online at: https://www.ijmacr.com

Volume – 9, Issue – 6, November – 2026, Page No.: 247 – 256

Estimation of the Age of Abrasions Using Gross Morphological and Histopathological Examination: A Cross-Sectional Study

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How to citation this article: Dr. Chandra Pal, Dr. Manoj Garg, Dr. Rajendra Singh, Dr. Pramod Kumar, Dr. O. P. Saini, Dr. Shalender Kumar, "Estimation of the Age of Abrasions Using Gross Morphological and Histopathological Examination: A Cross-Sectional Study", IJMACR– November – 2026, Volume – 9, Issue – 6, P. No. 247 – 256.

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Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Background: The present study, entitled "Estimation of the Age of Abrasions Using Gross Morphological and Histopathological Examination: A Cross-Sectional Study," aims to evaluate the morphological and histopathological features of abrasions in relation to the time elapsed since injury. By comparing the findings obtained through gross examination and histopathological analysis, the study seeks to assess their respective contributions to the estimation of abrasion age and explore the potential value of combining both techniques in routine forensic practice.

Methods: This Post-mortem study of wound dating by gross and histopathological examination of abrasion and bruise was carried out at the Department of Forensic Medicine & Toxicology, Sardar Patel Medical College, Bikaner from February 2021 to December 2021. **Results**: Bright red colour was seen in injuries upto12 hours old.

- Brown scab was seen after 22 h. Dark brown scab was observed only after 40 h. Black scab was observed in the injuries more than 4 days old.
- It took at least 5 days for the scab to fall from margin.

- Scab fallen off completely was observed after 10 days. Haemorrhage and congestion of vessels was seen in injuries less than 14 h. Predominant neutrophil infiltration was observed only after 18 h. Mononuclear cell infiltration was observed in injuries more than one day old. The granulation tissue was seen after 72 h. Collagen tissue formation was observed after 4 days.

Conclusion: Estimation of the age of abrasions is an important aspect of forensic medicine, as it may assist in the reconstruction of events and interpretation of medico-legal cases. Gross morphological examination provides a simple and practical method for assessing abrasion age through changes in colour, crust formation, drying, and healing. Histopathological examination provides additional information regarding tissue reactions, including haemorrhage, inflammatory cell infiltration, fibroblast proliferation, and re-epithelialisation.

Keywords: Abrasion, Gross, Histopathology

Introduction

Abrasions are among the most common types of blunt force injuries encountered in forensic practice. They occur due to the superficial damage or removal of the epidermis, usually resulting from friction, compression, or impact against a rough surface. Although abrasions are generally considered minor injuries, their examination can provide valuable information in the investigation of assaults, road traffic accidents, falls, and other medico-legal cases. Estimation of the age of an abrasion is particularly important in forensic medicine because it may help establish the approximate interval between the occurrence of an injury and its examination, thereby contributing to the interpretation of events in criminal and civil investigations.[1]

The gross morphological characteristics of abrasions change progressively during the healing process. Initially, an abrasion may appear as a raw, reddish area, followed by the formation of a serous or blood-stained crust. Subsequently, the crust dries, darkens, and eventually separates, leaving newly formed epithelium underneath. These changes are influenced by several factors, including the depth and extent of the injury, anatomical location, age and general health of the individual, local blood supply, infection, and environmental conditions. Consequently, the appearance of an abrasion may vary considerably among individuals, making precise age estimation based solely on gross examination challenging.[2]

Histopathological examination provides additional information regarding the tissue response to injury. The microscopic changes associated with wound healing include disruption of the epidermis, haemorrhage, inflammatory cell infiltration, changes in the underlying dermis, proliferation of fibroblasts, formation of new blood vessels, and re-epithelialisation. The appearance and progression of these changes may provide useful clues regarding the approximate age of an abrasion. However, the timing of histological changes varies, and considerable overlap may occur between different post-injury intervals. Therefore, histopathological findings should be interpreted cautiously and in conjunction with the clinical history and gross morphological findings.[3]

Gross morphological examination is relatively simple, economical, and readily available in routine medico-legal practice. In contrast, histopathological examination requires tissue sampling, laboratory processing, and microscopic evaluation but may provide additional evidence of the biological response to injury. A comparative assessment of these two approaches may

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help determine whether histopathological findings improve the reliability of age estimation beyond that obtained through gross examination alone.[4-5]

Despite the medico-legal significance of wound-age estimation, accurately determining the age of an abrasion remains a challenging task. Variations in individual healing responses and the influence of local and systemic factors limit the precision of existing methods. Furthermore, the interpretation of morphological and microscopic findings requires careful consideration of their limitations.[6]

The present study, entitled "Estimation of the Age of Abrasions Using Gross Morphological and Histopathological Examination: A Cross-Sectional Study," aims to evaluate the morphological and histopathological features of abrasions in relation to the time elapsed since injury. By comparing the findings obtained through gross examination and histopathological analysis, the study seeks to assess their respective contributions to the estimation of abrasion age and explore the potential value of combining both techniques in routine forensic practice.

Material & Method

After clearance from Ethical Committee, the study was conducted on 100 dead bodies having well demarcated abrasions & bruises and were received for medico-legal autopsy at the mortuary of Department of Forensic Medicine, S P Medical College and Associated group of Hospitals. After gross examination, abrasions and contusions were preserved in 10% formalin solution for the histopathological examination. Survival period was determined from relatives, police and hospital records.

The representative areas of injury were subjected to histopathological examination along with control samples from normal skin. After tissue processing, embedding, sectioning, H&E staining and cover slipping, slides were viewed under microscope.

Finally, the gross and histopathological changes were analyzed, and the conclusion was drawn after comparing and discussing with similar type of work carried out by foreign and Indian authors.

Inclusion Criteria:

- Cases where time of infliction of injuries known.

Exclusion Criteria:

- Cases where time of infliction of injuries not known.
- Cases which are suffering from co-morbidities like DM, Septicemia, Thyroid disorder and all immunocompromising conditions.
- Burn and decomposed bodies.

Microscopic scoring of abrasion

0- Hemorrhage and/or Congestion of vessels

1- Oedema formation

2- Margination of polymorph cells

3- Early infiltration of neutrophil cells

4- Predominant neutrophil infiltration with poorly differentiated mononuclear cells.

5- Predominant mononuclear cell infiltration

6- Fibroblast formation

7- Granulation tissue with rich leucocyte infiltration and much fibroblasts

8- Collagen tissue deposition

9- Cellular reaction subsides, fibroblast is more active with increased collagen formation (regression phase)

10- Organized pustule.

Microscopic scoring of Bruises

0 - Haemorrhage and Congestion of vessels

1- Oedema formation

2- Haematoma formation

3- Margination of neutrophil

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4- Early neutrophil infiltration

5- Neutrophil infiltration prominent with poorly differentiated monocyte

6- Predominant mononuclear cell infiltration

7- Necrosis

8- Collagen tissue deposition with copious hemosiderin

9- Decreased inflammatory cell with further increased collagen (Regression Phase)

Results

This post-mortem study of wound dating by gross and histopathological examination of abrasion was carried out at the Department of Forensic Medicine & Toxicology, Sardar Patel Medical College, Bikaner from February 2021 to December 2021.

Total 100 case were taken for study out of 100 cases, 79 were males and 21 were females. Maximum number of cases belonged to the age group of 20 – 30 yrs (33%), followed by 30 – 40 yrs (24%) and minimum number of cases belonged to the age group of 0 – 10 (3%) yrs.

Total 100 cases of abrasions were taken, out of which 87 cases were due to RTA and 06 cases were due to fall from height, 04 cases were due to assault and 03 cases were due to railway injury.

Table 1: Distribution of cases according to survival time

Age of injury	No of cases	Percentage
0-6 Hours	18	18.00%
6-12 Hours	17	17.00%
12-24 Hours	16	16.00%
24-48 Hours	13	13.00%
48-72 Hours	10	10.00%
3-7 Days	13	13.00%
1-2 Weeks	08	08.00%
>2 Weeks	05	05.00%
Total	100	100.00%

Table 2: Distribution of abrasions by its gross changes

Duration of Injury	Gross Changes (Abrasions)							Total
	Bright Red	Reddish Scab	Brownish Scab	Dark Brown Scab	Black Scab	Scab margin falling off	Scab fallen off completely	
0-6 hours	18	00	00	00	00	00	00	18
6-12 hours	07	10	00	00	00	00	00	17
12-24 hours	00	12	04	00	00	00	00	16
24-48 hours	00	06	05	02	00	00	00	13
48-72 hours	00	03	05	02	00	00	00	10
3-7 days	00	00	07	04	00	00	00	13
1-2 weeks	00	00	00	00	03	04	01	08

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>2 weeks	00	00	00	00	01	03	01	05
Total	25	31	21	08	06	07	02	100

Table 2 shows Distribution of abrasions by its gross changes 100 abrasions were studied, amongst which 25(25.0 %) showed bright red, 31(31.0 %) reddish scab, 21(21.0 %) brownish scab, 08(08.0 %) dark brown scab, 06(06.0 %) black scab and in 07(07.0 %) injuries the scab was fallen off at margins. In 02(02.0%) injuries the scab had fallen off completely.

Table 3: Earliest and routine appearance of gross changes of abrasions

Gross changes (Abrasions)	Earliest appearance	Routine appearance
Bright Red	10 min	0-4 Hours
Reddish Scab	05 Hours	12-24 Hours
Brownish Scab	22 Hours	24-72 Hours
Dark Brown Scab	40 Hours	4-7 Days
Black Scab	04 Days	1-2 Weeks
Scab margin falling off	05 Days	1-2 Weeks
Scab fallen off completely	10 Days	> 2 weeks

Table 3 shows Earliest and routine appearance of gross changes of abrasions according to time duration. Bright redness was observed earliest at 10 min and routinely at 0-4 Hours. Reddish scab was observed earliest at 05 Hours and routinely at 12-24 Hours. The earliest brownish scab was noted at 22 Hours. The routine appearance of the brownish scab is at 24-72 Hours. The earliest dark brown scab was noted at 40 Hours and routine appearance is at 4-6 days. The black scab was seen only after 04 days and routinely at 1-2 weeks. The fallen off of scab was noted only after 05 days and routinely at 1-2 weeks.

Table 4: Distribution of abrasions by their microscopic changes

Age of Injury	Microscopic Scoring											Total
	0	1	2	3	4	5	6	7	8	9	10	
0-6 Hours	13	01	04	00	00	00	00	00	00	00	00	18
6-12 Hours	08	01	04	04	00	00	00	00	00	00	00	17
12-24 Hours	02	00	00	02	12	00	00	00	00	00	00	16
24-48 Hours	00	00	00	00	05	05	02	01	00	00	00	13
48-72 Hours	00	00	00	00	03	03	01	03	00	00	00	10
3-7 Days	00	00	00	00	00	00	02	09	02	00	00	13
1-2 Weeks	00	00	00	00	00	00	00	01	03	03	01	08
>2 Weeks	00	00	00	00	00	00	00	01	01	02	01	05
Total	23	02	08	06	20	08	05	15	06	05	02	100

Table 4 shows Distribution of abrasions by its microscopic changes Among 23 abrasions, which showed only haemorrhage and/or congestion of vessels, 13(56.52%) were of 0-6 Hours old, 08 (34.78%) were of 7-12 Hours old and 02 (08.70%) were of 13-24 Hours old. The presence of congestion of vessels and/or haemorrhage was observed from 10

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minutes and last up to 06 Hours except in 02 injuries where it was observed at 13 Hours and 14 Hours. Early neutrophil infiltration was observed in 06 injuries, of which 04 (66.7%) injuries were of 07-12 Hours old. Prominent neutrophil infiltration was observed in 20 injuries, of which 12 (60.0%) were 13-24 Hours old, 05 (25.0%) were 25-48 Hours and remaining 03 (15.0 %) were of 49-72 Hours. Mononuclear cells infiltration was first noted at 30 Hours, and increased infiltration was observed in 08 injuries for 25-72 Hours. It was noted that predominant mononuclear infiltration was between 25-48 Hours in 5 (62.50%) injuries. The active fibroblasts were evident after 70 Hours. The granulation tissue deposition was noted in 15 injuries, of which 09 (60.0 %) were 4-7 days old, 01 (06.6%) was 25-48 Hours old, 03 (20.0%) were 49-72 Hours old, 01 (06.6%) injury was 1-2 weeks old and remaining 01 (06.6%) injury was of more than 02 weeks. The collagen tissue was noted in 06 injuries, of which 02(33.30%) injuries were 4-7 days old, 03 (50.0%) injuries were 1-2 weeks old and remaining 01 (16.70%) injury was more than 02 weeks old. The regression phase was noted in 05 injuries, of which 02 (40.0%) injuries were >2 weeks old and remaining 03(60.0%) injuries were of 1-2 weeks old.

Table 5: Earliest and routine appearance of common histologically changes detected in abrasions

Microscopic Changes	Earliest Appearance	Routine Appearance
Congestion/ Haemorrhage	10 Minutes	0-4 Hours
Oedema formation	20 Minutes	0-4 Hours
Migration of polymorph cells	45 Minutes	0-4 Hours
Early infiltration of neutrophil cells	06 Hours	4-12 Hours
Predominant neutrophilic infiltration	18 Hours	12-24 Hours
Mononuclear cell infiltration	30 Hours	24-72 Hours
Fibroblast formation	70 Hours	71-78 Hours
Granulation tissue deposition	72 Hours	4-6 Days
Collagen formation	96 Hours	7-14 Days
Regression phase	10 Days	> 2 weeks

Table 10 shows Earliest and routine appearance of common histologically changes detected in abrasions. The earliest appearance of Congestion/ Haemorrhage was noted at 10 minutes. The earliest formation of oedema was noted at 20 minutes. Migration of neutrophils was seen earliest at 45 minutes and routinely at 0-4 Hours. Early infiltration of neutrophil cells was seen earliest at 06 Hours. Predominant neutrophilic infiltration was noted earliest at 18 Hours. The earliest mononuclear infiltration was noted at 30 Hours. Earliest fibroblast formation seen at 70 hours and routinely at 71-78 hours. The earliest granulation tissue deposition (neovascularization) was noted at 72 Hours. The earliest collagen formation was seen at 96 Hours. The earliest regression phase was noted at 10th day.

Table 6.: Correlation of gross with microscopic scoring in Abrasions

Gross Changes	Microscopic Scoring (Abrasions)											Total
	0	1	2	3	4	5	6	7	8	9	10	
Bright Red	19	01	04	01	00	00	00	00	00	00	00	25

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Reddish Scab	04	01	04	05	13	04	00	00	00	00	00	31
Brownish Scab	00	00	00	00	07	03	04	06	01	00	00	21
Dark Brown Scab	00	00	00	00	00	01	01	05	01	00	00	08
Black Scab	00	00	00	00	00	00	00	04	02	00	00	06
Scab margin falling off	00	00	00	00	00	00	00	00	02	05	00	07
Scab fallen off completely	00	00	00	00	00	00	00	00	00	00	02	02
Total	23	02	08	06	20	08	05	15	06	05	02	100

Table:7: Distribution of bruises by their gross changes

Duration of Injury	Gross Changes (Bruises)					Total
	Reddish Colour	Bluish Colour	Brownish Colour	Greenish Colour	Yellowish Colour	
0-6 Hours	12 (12.4%)	05 (05.2%)	00 (00.0%)	00 (00.0%)	00 (00.0%)	17 (17.5%)
6-12 Hours	10 (10.3%)	07 (07.2%)	00 (00.0%)	00 (00.0%)	00 (00.0%)	17 (17.5%)
12-24 Hours	05 (05.2%)	10 (10.3%)	00 (00.0%)	00 (00.0%)	00 (00.0%)	15 (0.0%)
24-48 Hours	03 (03.1%)	08 (08.2%)	02 (02.1%)	00 (00.0%)	00 (00.0%)	13 (13.4%)
48-72 Hours	00 (00.0%)	07 (07.2%)	03 (03.1%)	00 (00.0%)	00 (00.0%)	10 (10.3%)
3-7 Days	00 (00.0%)	04 (04.1%)	08 (08.2%)	01 (1.03%)	00 (00.0%)	13 (13.4%)
1-2 Week	00 (00.0%)	02 (02.1%)	03 (03.1%)	01 (01.03%)	01 (01.03%)	07 (07.2%)
> 2 Weeks	00 (00.0%)	00 (00.0%)	01 (01.03%)	02 (02.1%)	02 (02.1%)	05 (05.2%)
Total	30 (30.9%)	43 (44.3%)	17 (17.5%)	04 (04.1%)	03 (03.1%)	97 (100 %)

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Table 7 shows distribution of bruises by their gross changes. 97 bruises were studied, amongst which 30 (30.9%) showed reddish discolouration, 43 (44.3%) bluish discolouration, 17 (17.5%) brownish discolouration, and 04 (04.1%) greenish discolouration and yellowish discolouration was observed in 03 cases (03.1%).

Discussion

This Post-mortem study of wound dating by gross and histopathological examination of abrasion and bruise was carried out at the Department of Forensic Medicine & Toxicology, Sardar Patel Medical College, Bikaner with association of Department of Pathology from February 2021 to December 2021.

Comparison of gross changes of abrasion by various workers

Study / Author	Bright Red	Reddish Scab	Brownish Scab	Dark Brown Scab	Black Scab	Scab margin falling off	Scab fallen off completely
Vinay J et al[7]	0 -12 hours	4-72 hours	12 hours - 6 days	1-06 days	4 days - >2 weeks	4 days- >2 weeks	7 days- >2 weeks
Devaraj PKDR[8]	0-12 hours	12-72 hours	12-72 hours	1-6 days	4-14 days	4-14 days	>2 weeks
Reddy K.S.N[9]	0-12 hours	12-24 hours	2-3 days	4-7 Days	4-7 days	-	> 1 week
Present Study	0-12 hours	6-72 hours	12 hours - 6 days	02-06 Days	1-2 week	1->2 week	1->2 week

In present study, among 23 abrasions, which showed only haemorrhage and/or congestion of vessels, 13(56.52%) were of 0-6 Hours old, 08 (34.78%) were of 7-12 Hours old and 02 (08.70%) were of 13-24 Hours old. The presence of congestion of vessels and/or haemorrhage was observed from 10 minutes and last up to 06 Hours except in 02 injuries where it was observed at 13 Hours and 14 Hours. The earliest formation of oedema was noted at 20 minutes.

Margination of neutrophils was observed during 0-6 Hours in 04 (50.0%) out of 08 injuries. This was seen earliest at 45 minutes and routinely at 0-4 Hours.

Early neutrophil infiltration was observed in 06 injuries, of which 04 (66.7%) injuries were of 07-12 Hours old. It was seen earliest at 07 Hours. Similar observation was made in a study by Sharma A et al.[10] where early neutrophil infiltration was found at 07 Hours and Saukko P et al.[11] also quotes that margination of polymorph occurs by 04 Hours.

Prominent neutrophil infiltration was observed in 20 injuries, of which 12 (60.0%) were 13-24 Hours old, 05 (25.0%) were 25-48 Hours and remaining 03 (15.0 %) were of 49-72 Hours. It was noted earliest at 18 Hours and progressive increase was noted in the injuries of 25-72 Hours old. Similar observation was made by Ross R et al.[12] where, in less than 12 hours the wound was rich in polymorph nuclear leucocytes, the numbers of those cells increased for the first 24 hours to a maximum.

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Mononuclear cells infiltration was first noted at 30 Hours, and increased infiltration was observed in 08 injuries for 24-72 Hours. It was noted that predominant mononuclear infiltration was between 24-48 Hours in 5 (62.50%) injuries. The earliest regenerative change of epithelium was noted at 02 days. The active fibroblasts were evident after 70 Hours. In a similar study by Sharma A et al.[13] early mononuclear infiltration was observed at 13 Hours itself whereas we noticed at 30 Hours.

Conclusion

Estimation of the age of abrasions is an important aspect of forensic medicine, as it may assist in the reconstruction of events and interpretation of medico-legal cases. Gross morphological examination provides a simple and practical method for assessing abrasion age through changes in colour, crust formation, drying, and healing. Histopathological examination provides additional information regarding tissue reactions, including haemorrhage, inflammatory cell infiltration, fibroblast proliferation, and re-epithelialisation.

The combined assessment of gross morphological and histopathological findings may provide a more comprehensive understanding of the healing process and improve the interpretation of the approximate age of abrasions. However, the rate of wound healing varies among individuals and is influenced by several local and systemic factors. Therefore, neither technique should be considered sufficient to determine the exact time of injury in every case.

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