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Original Research Article

Ageing of abrasions by gross and histopathological examination – study among dead bodies brought to modern mortuary, King George Hospital, Visakhapatnam

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ABSTRACT

Background: Dating injuries has important medico-legal implications. Abrasion age estimation in routine forensic practice relies mainly on gross examination, while histopathology provides objective microscopic evidence. However, their correlation remains insufficiently studied in India. To estimate the age of abrasions by gross and histopathological examination and correlate gross changes with microscopic findings.
Methods: This prospective observational study was conducted from August to December 2021 at Andhra Medical College, Visakhapatnam. Sixty-four medicolegal autopsy cases with known times of injury and death were included. A total of 118 abrasion samples underwent gross and histopathological examination using haematoxylin and eosin staining.
Results: The study included 51 males (79.68%) and 13 females (20.31%), with most aged 21–40 years (39.06%). Road traffic accidents accounted for 76.56% of cases and graze abrasions were most common (57.62%). Grossly, bright red discolouration was observed up to 6 hours, reddish scab up to 38 hours, brownish scab up to 115 hours, dark brown scab up to 140 hours and black scab from 140–290 hours. Vascular congestion was the earliest microscopic change (25 minutes), followed by oedema, inflammatory cell infiltration, fibroblast formation, granulation tissue, collagen formation and regression. Good correlation was observed.
Conclusions: Combined gross and histopathological examination may improve abrasion age estimation in medicolegal practice.

Keywords: Abrasion, Forensic medicine, Histopathology, Medicolegal autopsy, Wound dating

INTRODUCTION

The age estimation of mechanical injuries, whether in living or dead individuals, is of utmost importance in forensic investigation.[1,2] The age of injuries that are found at autopsy is a question that is heard regularly in the courtroom from the forensic pathologist and the opinion given can have wide-ranging medical and legal implications. Gross examination, histological examination and histochemical techniques are all used for the dating of a wound. The "naked-eye assessment" method is the main approach used for estimating the age of abrasions in routine forensic practice in India.[1] The precise age of an injury, based in the macroscopic appearance, is a forensic expert's big challenge. Results cannot be precisely determined because the inflammatory reaction in the local area is different in each individual. The chronology of injuries in conventional forensic medicine textbooks

appears inconsistent in the description of the injuries it dates and dating of mechanical injuries is difficult.[2,3] In the forensic setting, microscopic examination of wounds has been much more effective than gross examination. There is a large amount of research available on this subject; it is important to be able to tell whether a wound found at autopsy occurred before or after death and how long prior to death it was suffered. Unfortunately, there is a high degree of biological variation, which makes wound age estimation difficult and imprecise.[2] A number of surveys and wound classification systems employ histopathological methods to determine the age of the wounds. These changes can also vary with the size of the wound, the nature of the wound, the tissue it involves, the age and overall health of the victim and the presence or absence of infection.[4]

To determine the age of a wound, the exact timing of these repair processes are needed. Three consecutive and overlapping stages in the healing of a skin wound are inflammation, proliferation and maturation. Wound healing is a complex process of physical, histological and chemical changes and a systematic understanding of these changes can be used to determine the age of wounds.[3] It is not surprising that injuries examined with the naked eye can often be inconclusive and vary widely from one observer to another, as often the injuries require microscopic examination. Although several wound dating methods have recently been developed such as histochemistry and immunohistochemistry, there was no conclusive evidence yet that the gross appearance of the abrasions matched the histological changes reliably.[4]

Literature search indicates that there have been a variety of time periods associated with injury formation and gross appearance and variation in wound healing time according to location within the same person. Since the last years, the scientific field of wound age determination has made significant advances in the development of chemical analysis and immunohistochemistry.[2,4] A systematic and objective approach to wound healing assessment, without false impressions and stringent empirical criteria, might provide a solution to issues in wound dating in forensic medicine.[5] In this light, the present study was conducted to examine the accuracy of dating abrasions both macroscopically and microscopically and then compare the estimated age with the known infliction time of the abrasions as it was recorded in the police reports, the first information reports (FIR), hospital records and statement of the concerned relatives of the deceased. The observations made were compared to existing data in the literature to either substantiate or make recommendations for changes that could enable medicolegal issues to be addressed in a more objective and scientifically based manner.

Aims and objectives

To estimate the age of abrasions by gross changes. To estimate the age of abrasions by histopathological examination. To correlate gross and microscopic changes in relation to the time of infliction of injury.

METHODS

Study design and setting

This was a prospective observational study conducted in the Department of Forensic Medicine and Toxicology, Andhra Medical College, Visakhapatnam, in association with the Modern Mortuary, King George Hospital (KGH), Visakhapatnam, over a period of five months from 1st August 2021 to 31st December 2021.

Sample size

A total of 64 medicolegal autopsy cases fulfilling the inclusion criteria were enrolled. One hundred and eighteen abrasion samples were collected from these cases.

Inclusion criteria

All medicolegal autopsy cases in which the time of infliction of injury and the time of death were documented and known, across all age groups, were included in the study.

Exclusion criteria

Cases with unknown time of infliction of injury or time of death, decomposed or mutilated bodies, spot-dead cases and cases with inadequate history were excluded.

Data Collection

Data were sourced from police requisitions, inquest reports, crime scene photographs and videos, clinical records and post-mortem findings. All information was collated and analysed using a pre-designed master sheet.

Gross examination

The abrasions were examined macroscopically with respect to colour, surface characteristics and the state of the scab. The gross changes were classified into seven categories: bright red, reddish scab, brownish scab, dark brown scab, black scab, scab falling off at margins and scab fallen off completely.

Histopathological examination

Tissue samples from the abrasions were collected at autopsy, fixed in 10% formalin, processed routinely and embedded in paraffin. Sections of 4–5 micron thickness were cut and stained with haematoxylin and eosin (H&E). Microscopic changes were graded using a 10-point scoring system (Score 0 to Score 10) based on the sequential histological changes of wound healing, including vascular congestion/haemorrhage, oedema, neutrophil margination, neutrophil infiltration, mononuclear cell infiltration,

fibroblast formation, granulation tissue deposition, collagen formation and regression.

Statistical analysis

Data were recorded in a master sheet and analysed using descriptive statistics. Results are presented as frequencies and percentages.

Ethical clearance

The study was approved by the Institutional Ethics Committee, Andhra Medical College, Visakhapatnam (Serial No: 298/IEC AMC/AUG 2021).

RESULTS

Overview

A total of 761 medicolegal autopsies were conducted during the study period. Of these, 64 cases fulfilling the inclusion criteria were selected, yielding 118 abrasion samples for analysis.

Age and sex distribution

Of the 64 cases, 51 (79.68%) were males and 13 (20.31%) were females, reflecting the greater involvement of males in outdoor and occupational activities. The most commonly affected age groups were 21–40 years (25 cases, 39.06%) and 41–60 years (24 cases, 37.50%).

Cause of injury

Road traffic accidents (RTA) accounted for the majority of cases (49 cases, 76.56%), followed by fall from height (8 cases, 12.50%), other accidental causes (5 cases, 7.81%), railway injury (1 case, 1.56%) and assault (1 case, 1.56%).

Type of abrasions

Of the 118 samples analysed, 68 (57.62%) were of the graze type, 47 (39.83%) were pressure abrasions, 2 (1.69%) were imprint abrasions and 1 (0.85%) was a scratch abrasion.

Distribution by age of injury

Among the 118 samples: 10 (8.47%) were 0–4 hours old, 12 (10.16%) were 4–12 hours, 14 (11.86%) were 12–24 hours, 34 (28.81%) were 24–72 hours, 25 (21.18%) were 4–6 days, 21 (17.79%) were 7–14 days and 2 (1.69%) were more than 2 weeks old.

Gross changes

Table 1 summarises the correlation of gross changes with the age of abrasion. The earliest, routine and latest appearances of each gross change are shown in Table 2. Representative photographs of abrasions at different gross stages, with their corresponding photomicrographs, are shown in Fig. 11–12, Fig. 23–24, Fig. 26–27 and Fig. 30–31.

Microscopic changes

The microscopic scoring data are summarised in Table 3. The scoring system used was as follows: score 0–haemorrhage and vascular congestion; score 1–oedema formation; score 2–margination of neutrophils; score 3–early infiltration of neutrophils; score 4–predominant neutrophilic infiltration with few mononuclear cells; score 5–predominant mononuclear cell infiltration; score 6 –fibroblast formation; score 7–granulation tissue deposition; score 8–collagen tissue deposition; score 9–regression phase (cellular reaction subsides, active fibroblasts, raised collagen formation).

Figure 1 (A and B): Fresh graze abrasion (bright red colour, 2 h old) with corresponding microphotograph showing oedema and congested vessels without inflammatory response (H&E, 40X).

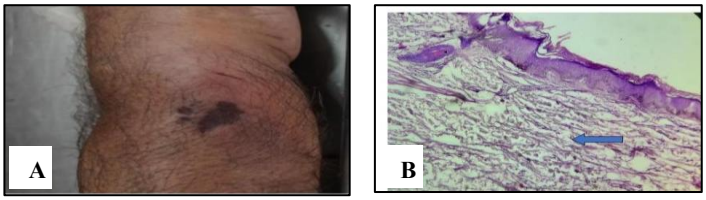

Figure 2 (A and B): Pressure abrasion (dark brown colour, 5 days 12 h old) with corresponding microphotograph showing granulation tissue deposition (H&E).

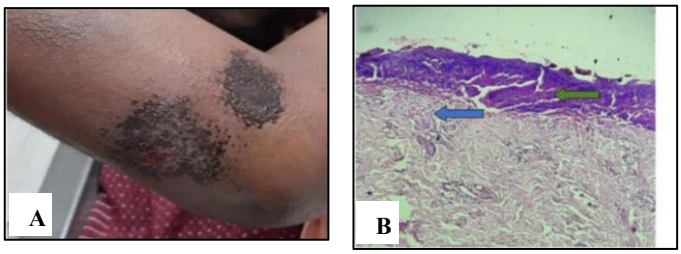

Figure 3 (A and B): Grazed abrasion (dark brown colour, 5 days old) with corresponding microphotograph showing crust formation correlating with scab formation and granulation tissue deposition (H&E, 10X).

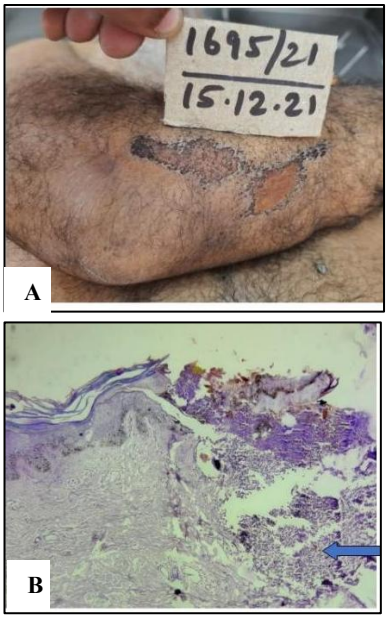

Figure 4 (A and B): Grazed abrasion with scab fallen at margins and pus formation (8 days 10 h old) with corresponding microphotograph showing an organised pustule rich in neutrophils (H&E, 40X).

Table 1: Correlation of gross changes with age of abrasion (n=118).

Age of injury	Bright red	Reddish	Brownish	Dark brown	Black scab	Margins falling off	Total no (%)
0–4 h	10	0	0	0	0	0	10 (8.47)
4–12 h	4	8	0	0	0	0	12 (10.16)
12–24 h	0	10	4	0	0	0	14 (11.86)
24–72 h	0	6	24	4	0	0	34 (28.81)
4–6 Days	0	0	1	22	2	0	25 (21.18)
7–14 Days	0	0	0	0	6	14	21 (17.79)
>2 Weeks	0	0	0	0	0	0	2 (1.69)
Total	14	24	29	26	8	14	118 (100.0)

Table 2: Earliest, routine and latest appearance of gross changes of abrasions.

Gross Change	Earliest Seen	Routinely Seen	Latest Seen
Bright red	25 min	0–4 h	6 h
Reddish scab	8 h	12–24 h	38 h
Brownish scab	17 h	24–72 h	115 h
Dark brown scab	47 h	4–6 days	140 h
Black scab	140 h	7–14 days	290 h
Scab fallen off at margins	150 h	7–14 days	268 h
Scab fallen off completely	252 h	>2 weeks	—

Table 3: Correlation of microscopic changes with age of abrasion (n=118).

Age	0	1	2	3	4	5	6	7	8	9	Total (%)
0–4 h	4	2	4	0	0	0	0	0	0	0	10 (8.47)
4–12 h	2	0	4	3	3	0	0	0	0	0	12 (10.16)
12–24 h	0	0	0	2	12	0	0	0	0	0	14 (11.86)

Continued.

Age	0	1	2	3	4	5	6	7	8	9	Total (%)
24–72 h	0	0	0	0	11	16	3	4	0	0	34 (28.81)
4–6 Days	0	0	0	0	0	0	1	18	6	0	25 (21.18)
7–14 Days	0	0	0	0	0	0	0	2	13	5	21 (17.79)
>2 Weeks	0	0	0	0	0	0	0	0	0	1	2 (1.69)
Total	6	2	8	5	26	16	4	24	19	6	118 (100)

Table 4: Earliest and routine appearance of microscopically detected changes.

Microscopic change	Earliest seen	Routinely seen
Congestion / Haemorrhage	25 min	0–4 h
Oedema formation	3 h	0–4 h
Margination of neutrophils	4 h	0–4 h
Early infiltration of neutrophils	10 h	4–12 h
Predominant neutrophilic infiltration	12 h	12–24 h
Mononuclear cell infiltration	31 h	24–72 h
Fibroblast formation	53 h	71–78 h
Granulation tissue deposition	47 h	4–6 days
Collagen formation	5 days	7–14 days
Regression phase	10 days	>2 weeks

DISCUSSION

In the present study, 64 medicolegal autopsy cases were analysed wherein 118 abrasions were identified and the gross and histopathological findings were correlated with the known time of the occurrence of injury. The estimation of time of injury at post mortem examination is an important and relevant forensic enquiry, because it may have direct implications for the reconstruction of events of death.[1,2] The current results are in line with those published in the literature and are of significance for forensic practice in this area.

The predominance of males (79.68%) in the study group is similar to that of Anil Mangeshkar et al and Vinay J et al, who also found that males predominated in their series.[3,4] This is due to the greater exposure of males to road traffic and occupational hazards. As per the findings of Vijay Kumar et al and Siddiqui et al the economically active age groups in the present study (21–40 years and 41–60 years) are at higher risk.[5,6]

The most common cause of the accidents was RTA, accounting for 76.56%, which is comparable with the findings of Vinay et al who reported 85.2% of the accidents to be caused by road traffic accidents.[4] The most frequently reported type of injury was "grazed" (57.62%), as this is the most common type of road traffic injury caused by rubbing against the road surface.

Gross changes

Bright red discolouration was noted in injuries from less than 6 hours old and was present as early as 25 minutes. This is in accordance with the findings of Vinay et al who observed bright red colour of injuries within 5 hours of its occurrence and Mangeshkar et al who observed that 88.9% of injuries that were fresh abrasions exhibited a bright red colour.[3,4] The skin became red as early as 10 minutes, as reported by Sharma et al.[7] This is in contrast to Kumar et al, where dark red colour was observed instead of bright red colour on first day.[1]

In the present study, the 12–24 hour group had the highest percentage (41.66%) of reddish scab and the scab was observed from 8 hours and persisted till 38 hours. The same trend was observed by Vinay et al who reported reddish scab developing at 6 hours.[4] These timings are confirmed by Nandy et al and Mangeshkar et al.[3] The current results correspond with those of Sharma et al who reported the appearance of reddish scab at around 7 hours.[7]

Brownish scab was first sighted at 17 hours with 82.75% of brownish scab being in the 24-72 hour age group. The results are consistent with those of Vinay et al and Sharma et al who have observed the appearance of brownish scab by the 2nd and 3rd day respectively and Nandy A who observed brownish scab after the 3rd day.[4,7,8] Reddish-brown scab was also observed between 2-3 days by Anil Mangeshkar et al.[3] It was contrasted with Kumar et al who reported scab in dark red color on the third day.[1]

Dark brown scab was first observed at 47 hours and 84.61% occurred in the 4-6 day age group. This is similar to the observations of Vinay et al and Nandy A which noted the formation of dark brown scab on the 4th and 5th day. Sharma et al, reported a hard brown scab after 27 hours whereas in the present study, scab was hard brown after 48 hours.

Black scab was found in wounds older than 5 days, ranging from 140 to 290 hours with 75% of cases in the 7–14 day group. It is in accordance with the findings of Vinay et al who reported the presence of black scab in all old abrasions and Mangeshkar et al who reported black scab in all abrasion more than 7 days old.[3,4] Only in the present study scab falling off at the margins was noted and complete scab detachment was observed after 10 days (252 hours) as reported by Vinay et al and Krishan after 10 days.[4,9]

Microscopic changes

Vinay et al and Kumar et al observed the earliest changes in the histological changes were vascular congestion and haemorrhage, which were first observed at 25 minutes.[4,5] These results are consistent with the acute vascular reactions to injury as detailed in typical wound healing literature.[10,11] In the present study, the first signs of oedema were observed at 3 hours. Onset of oedema was reported by Vinay et al as early as 15 minutes which is a contrast with the current finding, perhaps due to variation in case selection and staining sensitivity.[4]

The margination of neutrophils was seen from 4 hours with 50% of the cases belonging to the 0-4 hours group. This is in tune with Vinay et al and Kumar et al Neutrophil infiltrations were observed as early as 10 hours and they were predominantly seen in the group of 4–12 hours.[4,5] However, Sharma et al reported polymorphic infiltration 2 hours before.[7] In the present series there was no definite evidence of inflammation up to 4 hours, partially agreeing with Nandy et al.[8]

Predominant neutrophilic infiltration was first observed in the 12 hour group and was most common in the 12–24 hour and 24–72 hour groups. This is in line with Vinay et al, Kumar et al and Sharma et al.[4,5,7] Nandy et al reported that neutrophils have the peak count after 24 hours and remain so for 2–3 days and similar results were obtained in the present study.[8]

The first evidence of mononuclear cell infiltration was observed at 31 hours and the 24–72 hours group had a higher infiltrate of mononuclear cells. It is found to be similar to the result obtained by Vinay et al, Kumar et al and Sharma et al.[4,5,7] A rise in macrophages was observed from 16 to 24 hours by Nandy et al.[8] The formation of fibroblasts occurred earliest at 53 hours, that of granulation tissue occurred earliest at 47 hours and that of collagen formation occurred after 5 days. The results are in line with the healing cascade presented by Kondo and Ishida, Vinay et al and Kumar et al.[4,5,12] The regression phase was observed from the 10th day, which matches with Kumar et al.[5]

Correlation of gross and microscopic changes

On comparing gross changes with microscopic findings, good correlation was demonstrated. Among injuries aged 12–24 hours, 10 of 14 showed reddish scab on gross examination, while 12 of 14 showed predominant neutrophilic infiltration on histology, confirming the age of the injury. In injuries aged 4–6 days, 22 of 25 showed dark brown scab grossly, while 18 of 25 demonstrated granulation tissue deposition histologically, corroborating an injury age exceeding 4 days. These correlations support the utility of combining gross and histopathological assessment for objective wound age estimation, as recommended in the literature.[2,4,13]

Limitations

This study has several limitations. It was conducted at a single tertiary care centre over a relatively short period of five months and included a limited number of cases. The study was restricted to medicolegal autopsy cases with a known time of injury, which may limit the generalisability of the findings to other populations and clinical settings. In addition, wound healing and histopathological changes may vary according to factors such as age, general health, wound characteristics, anatomical site and infection. The study primarily relied on routine histopathological examination with H&E staining and did not evaluate advanced techniques such as immunohistochemistry or enzyme histochemistry, which may provide additional information for wound age estimation. Therefore, the findings should be interpreted in the context of these limitations and larger multicentric studies incorporating advanced histological and molecular techniques are warranted.

CONCLUSION

A total of 118 abrasions were studied and gross, histopathological examination was used to age 64 autopsy cases in the present study. The results show that both methods are valid tools for age estimation of abrasions and that gross findings were confirmed with the help of the objective histopathological analysis. The most common cause of injury was from road traffic accidents, most frequently graze abrasions and the working age group of males were the most commonly injured age group.

The sequential colour changes of abrasions from bright red through reddish, brownish, dark brown and black scab and then scab detachment, was consistently correlated with the age of the abrasion on gross examination. Histopathologically, the course of inflammatory and reparative changes followed a pattern that duplicated the gross observations and was similar to the known wound healing cascade. The relationship between gross and microscopic changes was acceptable and histopathological examination provided more objective and repeatable evidence.

Ablations in medicolegal cases should be routinely submitted for histopathological examination, especially in cases of suspected child abuse, sexual assault and cases

where the date of injury is in question. This will help ensure objectivity, accuracy and help justice be served.

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