

## Study on the Determination of the Age of Bruise from the Process of Healing

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Received: 25-06-2024 / Revised: 23-07-2024 / Accepted: 25-08-2024

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Conflict of interest: Nil

### Abstract:

**Introduction:** The following study has discussed that bruising is a critical aspect of forensic medicine. It results from trauma that leads to bleeding beneath the skin. It can help comprehend the color progression of bruises, which is important in determining the age of injuries, mainly in forensic investigations. The healing process involves a series of predictable color changes due to hemoglobin breakdown. It can assist in medico-legal cases such as child abuse, assaults, and unexplained deaths.

**Aim:** This study aims to define the age of bruises based on the recovery process by analyzing color changes over time, which provides a scientific basis for forensic evaluations.

**Method:** A descriptive observational study was conducted on 30 patients admitted to emergency care with documented injury histories. Color changes in bruises were observed and recorded over a period of days. Statistical analysis was performed using SPSS, with a p-value <0.05 considered significant. Ethical approval was obtained before conducting the study.

**Results:** The findings show the distribution of age among 30 participants, with the majority (53%) in the 21-30 age range, followed by 27% in the 31-40 group. No participants were in the 51-60 age bracket. Bruise color changes were observed, with red in the first 12 hours, transitioning to bluish, bluish-black, and greenish-yellow stages, and then to yellow and normal by Day 16, reflecting a typical healing process.

**Conclusion:** The study has concluded that there is distinct patterns in both age distribution and bruise color progression among the sample group. The majority of participants fall within the 21-40 age range, indicating a focus on early to mid-adulthood.

**Keywords:** Bruise Aging, Forensic Medicine, Wound Healing, Color Changes, Injury Assessment.

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### Introduction

Any injury resulting from an accident or assault — occurring in the form of trauma — is an essential aspect of forensic medicine. Bruising is a discoloration in a particular area of the skin caused by bleeding beneath the epidermis (skin) after a blunt impact injury. The wounds can range from the size of a pinhead to a large collection of blood in the tissues [1]. The formation of bruises at a particular time, skin breakdown due to the impact of force in small blood vessels, and blood seeps in fully surrounding connective tissue to activate the cellular response and infiltration in bleeding with neutrophil granulocytes and macrophages. Healing a wound undergoes stages of discoloration. However, certain changes are occurred due to the breakdown of haemoglobin and damage to subcutaneous vessels. After that, some symptoms may occur in the form of bruising and swelling, almost swelling around the bleeding. The blood vessels develop an inflammatory reaction and bleed rapidly [2]. Most commonly the bleeding occurs

between the dermis and hypodermis. There are specific criteria for creating a wound. The first criteria are rupture of the blood vessels and damage or breakdown of skin. The second criterion is to allow high enough blood to flow to connective tissue. The third criterion is bleeding location; blood can fill under the skin surface to recognize the wound. Blood leakage depends on two factors: the amount of blood outside blood vessels in nearly surrounding tissue and blood being drained in depth under the skin [3]. The color of the wound can vary greatly depending on the victim's age, natural skin color, and ambient lighting. The diffuse reflectance spectrum (DRS) measurements in the visible spectral range and analysis of lesions have recently been proposed. Nowadays, Pulsed photothermal radiometry (PPTR) offers a potential technique for estimating the missing information. It produces mid-infrared (IR) emission due to pulsed laser radiation used to analyse the depth profiles

that can be reconstructed immediately after laser exposure [4].

Bruises are not minor injuries; they can lead to mortality. Age is one of the most sought-after data for the determination of forensic examinations, especially in child abuse and violent deaths. When the mortality cause and timing of the injury are necessary. A bruise is formed once; the body can react and activate the inflammatory mediators surrounding the bleeding site. The inflammatory mediators first activate in granulocytes and later mononuclear macrophages. Certain periods do not allow for filtration due to interruptions in age [5].

The age of the wound examination is almost as crucial in medico-legal death cases as the time of injury formation or until death. A bruise is defined as an impairment of the dermal layer. It can lead to temporary or permanent loss of physiological characteristics in the skin. Wound healing is an essential process that can occur automatically in the body based on the condition of the wound. It can respond to sequential cellular, physiological, and biochemical events that are changes in the body. Until now, scientists have not fully understood the Wound healing mechanism [6].

In the first few minutes, the wound healing process is said to heal the wound and can last for days, months, and years. These processes are related to body homeostasis, inflammation, proliferation, maturation, and remodeling. When trauma occurs, platelet aggregation is required to respond to the coagulation mechanism by releasing platelets and fibrous tissue from the injured blood vessel. This results in the release of thrombin and fibronectin from the alpha particles of platelets, which in turn leads to the release of cytokines [7]. Cytokines are proteins released from specialized cells. Cytokines include transforming growth factors, tumor necrosis factors (TNFs), interferons, lymphokines, colony-stimulating factors, and growth factors. This is especially true during the early stages of wound healing.

## Method

**Research Design:** This descriptive observation study was conducted among 30 patients admitted to our hospital from 2016 to 2018. This trial included those participants who were given consent. In addition, this study included those participants who had a history regarding the infliction of injuries. The treatment case sheet was examined based on the requirements, and the injuries were analysed. Even the time of infliction was registered and repeated subsequent examination was conducted at the time of the first inspection.

## Inclusion and Exclusion Criteria

### Inclusion

- This study included those patients who had past records regarding the inflicted injuries, confirmed through medical examination and history-taking.
- Patients who gave informed consent for participation in the study.

### Exclusion

- Patients who refused to give informed consent for participation in the study.
- Patients who had incomplete medical records or insufficient injury history.

## Statistical Analysis

In order to conduct this study, SPSS tools were used to analyze the data. A p-value <0.05 was considered statistically significant.

**Ethical approval:** Our ethical committee approved this study.

## Result

Table 1 displays the age distribution of a sample including 30 persons, divided into five age categories. Most responders (53%) are 21–30 years old, making up over half of the sample. The 31–40 age cohort constitutes 27% of the sample, whilst the 18–20 age cohort represents 13%. There are no cases in the 51–60 age bracket, although 10% are 41–50. This distribution indicates that the sample primarily consists of persons in early to mid-adulthood, with limited representation from older age demographics.

**Table 1: Observational findings of Indian authors**

| S. No. | Age in Years | Total (N=30) | No. of Cases | Percentage (%) |
|--------|--------------|--------------|--------------|----------------|
| 1      | 18 – 20      | 4            | 4            | 13%            |
| 2      | 21 – 30      | 16           | 16           | 53%            |
| 3      | 31 – 40      | 8            | 8            | 27%            |
| 4      | 41 – 50      | 3            | 3            | 10%            |
| 5      | 51 – 60      | 0            | 0            | 0%             |

Table 2 shows how the colour of contusions changed over time for 30 patients. All patients (100%) showed red discolouration within 0-12 hours, indicating new injuries. By 12-24 hours, 47% of cases had a bluish hue that lasted for the next 24-48 hours in the same proportion, but just 3% had this colour by Day 3. The bluish-black stage peaked on Day 3 in 50% of cases, then decreased to 43% on Day 4, 7% on Day 5, and 3%

on Day 6, suggesting bruises naturally transition. By Day 4, 10% of instances had a brown center with a green border, rising to 37% on Day 5 and 33% on Day 6 before tapering off. By Day 7-9, only 3-13% of cases were in this stage, signifying the last healing phase. The data shows a predictable bruise evolution pattern, relevant for forensic and medical injury timing assessments.

**Table 2: Age distribution of patients**

| Condition                                | Time          | Total (N=30) | No. | Percentage (%) |
|--|---------------|--------------|-----|----------------|
| Red                                      | 0-12 hours    | 30           | 30  | 100            |
| Bluish                                   | 12 – 24 hours | 14           | 14  | 47             |
|  | 24-48 hours   | 14           | 14  | 47             |
|  | Day - 3       | 1            | 1   | 3              |
| Bluish-Black                             | Day - 3       | 15           | 15  | 50             |
|  | Day - 4       | 13           | 13  | 43             |
|  | Day - 5       | 2            | 2   | 7              |
|  | Day - 6       | 1            | 1   | 3              |
| Brown in the center with green periphery | Day - 4       | 3            | 3   | 10             |
|  | Day - 5       | 11           | 11  | 37             |
|  | Day - 6       | 10           | 10  | 33             |
|  | Day - 7       | 4            | 4   | 13             |
|  | Day - 8       | 1            | 1   | 3              |
|  | Day - 9       | 1            | 1   | 3              |

Table 3 illustrates the time course of a condition among a sample of 30 individuals, classified into three stages: greenish-yellow, yellow, and normal. The greenish-yellow state is most common between days 6 and 12, reaching its zenith on day 8 at 27%, before progressively diminishing. The yellow stage commences on day 8, peaks at 27% on day 10, and subsequently declines until day 14. The shift to the normal stage commences on day 10 (13%) and

progressively escalates, reaching a zenith on day 12 (30%), signifying a notable recovery trend. By day 16, merely 3% of the cases remained classified as normal, indicating that the majority of individuals had recovered by this time. This pattern signifies a progressive enhancement over time, transitioning from greenish-yellow to yellow and finally to normal after roughly 10 to 16 days.

**Table 3: Colour changes during early injury healing**

| Condition       | Time     | Total (N=30) | No. | Percentage (%) |
|-----------------|----------|--------------|-----|----------------|
| Greenish yellow | Day - 6  | 2            | 2   | 7              |
|                 | Day - 7  | 7            | 7   | 23             |
|                 | Day - 8  | 8            | 8   | 27             |
|                 | Day - 9  | 6            | 6   | 20             |
|                 | Day - 10 | 4            | 4   | 13             |
|                 | Day - 11 | 2            | 2   | 7              |
|                 | Day - 12 | 1            | 1   | 3              |
| Yellow          | Day - 8  | 4            | 4   | 13             |
|                 | Day - 9  | 6            | 6   | 20             |
|                 | Day - 10 | 8            | 8   | 27             |

|        |          |   |   |    |
|--------|----------|---|---|----|
|        | Day - 11 | 6 | 6 | 20 |
|        | Day - 12 | 4 | 4 | 13 |
|        | Day - 13 | 1 | 1 | 3  |
|        | Day - 14 | 1 | 1 | 3  |
| Normal | Day - 10 | 4 | 4 | 13 |
|        | Day - 11 | 6 | 6 | 20 |
|        | Day - 12 | 9 | 9 | 30 |
|        | Day - 13 | 5 | 5 | 17 |
|        | Day - 14 | 4 | 4 | 13 |
|        | Day - 15 | 1 | 1 | 3  |
|        | Day - 16 | 1 | 1 | 3  |

Table 4 shows the colour change chronology from N.G. Rao, K. Vij, and K.S.N. Reddy. Initially, blood manifests as vivid crimson upon production. It exhibits a bluish hue within a few hours to the third day, signifying initial disintegration. On the second day, K. Vij observes a bluish-purple stage that is not seen in the other sources. The blood turns bluish-black or brown by day three to four.

By the fourth to sixth day, a greenish tint appears, indicating more decomposition. The yellow stage occurs between the seventh and twelve days, with K. Vij indicating a marginally earlier shift. Therefore, the blood resumes a normal appearance after roughly two weeks. It illustrates the basic phases of postmortem blood discoloration, valuable for determining the time period since death.

**Table 4: Colour change chronology**

| Color Change       | N.G. Rao            | K. Vij          | K.S.N. Reddy        |
|--------------------|---------------------|-----------------|---------------------|
| Bright Red         | Freshly produced    | Fresh           | Fresh               |
| Bluish             | Few hours – 3rd day | Few hours       | Few hours – 3rd day |
| Bluish Purple      | -                   | 2nd day         | -                   |
| Bluish Black/Brown | 4th day             | 3rd – 4th day   | 4th day             |
| Greenish           | 4th – 5th days      | 5th – 6th day   | 5th – 6th day       |
| Yellow             | 7th – 12th days     | 7th – 10th days | 7th – 12th days     |
| Normal             | 2 weeks             | 2 weeks         | 2 weeks             |

## Discussion

Bruising is a discoloration in a particular area of the skin caused by bleeding beneath the epidermis (skin) after a blunt impact injury. 70% of ACL (anterior cruciate ligament) tears are approximately associated with bone bruises. It should be diagnosed with different patterns of localization and severity, which also constitute the mechanism of injury. In 1989, Mink and Deutsch first identified and classified bone lesions and magnetic resonance imaging was used to diagnose the injured knee. Bone lesions may arise, with altered bone marrow intensity seen as very low intensity on T1-weighted sequences and sometimes with increased intensity on T2-weighted sequences, Papalia R et al., [8]. Robin S et al. was conducted and tested in vivo with patients or animal models. The model was used to screen topical creams using in-vivo human skin renditions of human-induced wounds, which are very close to in vivo conditions. Apigenin has anti-inflammatory properties; it can

reduce the infiltration of inflammatory cells in patients. It can inhibit the secretion of prostaglandins, arachidonic acid, keratinocytes, cyclooxygenase-2 (COX-2), NOS (nitric oxide synthase) and pro-inflammatory cytokines like TNF  $\alpha$  and IL-6. It is very effective in treating inflammatory processes, especially in the skin, and is responsible for synthesizing free radicals. Finally, they revealed that apigenin and arnica extract were mixed with the application, reducing the area of induced wounds compared to the control group [9].

Vidovich L et al. conducted a study combining pulsed photothermal radiometry and diffuse reflectance spectroscopy. This type of study has been undertaken previously, but here, both are demonstrated to be subject to limitations. Both techniques are used for measurements, considering spectral and geometric properties. This study mainly focuses on the joint analysis's fitting approach and subsequent optimization. Diffuse

reflectance spectroscopy is used to analyze healthy skin; the values are compared using the DA approach and the inverse MC yield parameter. The DA approach reveals large concentrations of strongly absorbing hemoglobin in the wound, challenging the scattering-dominated tissues. The MC approach is more favorable and does not allow for disputes over the validity of the DA, as it causes a “red loss” effect [10].

Toson et al. show that *Rebaulia hemispherica*, *Plagiochasma rupestre*, and *Tarkionia hypophylla* are a group of extracts used to treat wounds to accelerate wound healing. This study was observed in vehicles, and negative control groups were used to compare and analyze the delay in wound healing processes. Hematoxylin & Eosin (HE) is a part of the skin sections, and Van Giesen (VG) is another part of the skin sections, which is considered as skin B. The data refers to *Corcinia coriandrina*, *Borella platyphylla*, *Tarkionia hypophylla*, *Rebaulia hemispherica*, negative control, *Riccia fluytens*, vehicle, etc. Fibroblast, mononuclear cells, collagen, and polymorphonuclear cells occur during wound healing [11].

Many people may suffer from chronic wounds. There has been more progress in medicine than in the past in treating wounds. Physical wounds can lead to skin breakdown. Usually, they can cause infection, mainly if they cause poor hygiene conditions and reduce their quality of life. In many studies on the development of new wound-healing agents. Anti-inflammatory, antioxidant antibiotics are available in natural products and help promote wound healing. Antioxidant compounds prevent lipid peroxidation to prevent cell damage. Antimicrobial compounds are also essential for wound healing to kill microorganisms such as *Staphylococcus aureus*, *Streptococcus pneumoniae*, and *Klebsiella pneumoniae*. It closes the wound and restores the functional barrier. Homeostasis, inflammation, cellular proliferation, and migration are several processes that occur during wound healing. At the end of collagen coverage, wound healing is called the maturation and remodeling phase [11,12].

### Conclusion

The study has concluded that there is distinct patterns in both age distribution and bruise color progression among the sample group. The majority of participants fall within the 21-40 age range, indicating a focus on early to mid-adulthood. In terms of bruise healing, the data demonstrates a predictable color progression from red to bluish-black, greenish-yellow, yellow, and eventually to normal, offering valuable insights for forensic and medical assessments of injury timing and recovery. The clinical contribution of this study lies in its detailed analysis of bruise color progression over time,

which can aid in more accurate assessment of injury timelines in forensic and medical settings. The predictable color changes observed—from red to bluish-black, greenish-yellow, yellow, and normal—provide a reliable framework for estimating the age of injuries, which can be crucial in both clinical diagnostics and legal investigations. Additionally, the age distribution data enhances the understanding of demographic patterns in injury occurrences.

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