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Retrospective study on skin reddening and petechiae in the eyelids and the conjunctivae in forensic physical examinations

Received: 9 December 1996 / Received in revised form: 14 March 1997

Abstract Skin reddening with or without additional changes such as pinpoint intracutaneous hemorrhages and/or minute superficial scratches was observed in 165 out of 739 physical examinations (reddening with additional changes: $n = 81$; reddening only: $n = 84$). The most common site where reddening was observed was the neck region (reddening with additional changes: $n = 30$; reddening only: $n = 34$). In over 85% of the cases, the postinflation interval (Pi) was ≤ 1 day, and there were 12 and 10 cases with $1 < Pi \leq 3$ days, respectively. Among these 22 cases, there were 5 cases with $2 < Pi \leq 3$ days, (reddening with additional changes: $n = 4$; reddening only: $n = 1$). The maximum Pis were almost 3 days, and 2 days and 13 h, respectively. These results demonstrate that reddening of the skin with and that without additional changes (in particular petechiae) were detectable up to approximately 3 and 2 days after the event, respectively. Furthermore, in 17 out of 64 cases with reddening in the neck, petechial hemorrhages were seen in the eyelids and/or conjunctivae (reddening with additional changes: $n = 10$; reddening only: $n = 7$). The maximum Pi in which petechial hemorrhages were detectable in the eyelids and/or the palpebral conjunctivae was 1 day and 21 h. The present study indicates that physical examinations within 2 or 3 days after the event seem to be more suitable to find skin reddening and/or petechiae in the eye lids and/or the conjunctivae.

Key words Physical examination · Postinflation interval · Skin reddening · Petechial hemorrhages · Microcirculation

Introduction

Forensic physicians perform not only autopsies but also physical examinations of living persons (victims or assailants) in cases of sexual assault, physical abuse, attempted homicide and others. During the physical examination any marks of injury on the body surface must be recorded; skin reddening as well as deep abrasions, bruises and incised wounds are significant findings under medico-legal aspects [1, 2]. In addition, when some reddenings are observed in the neck region, forensic physicians look for petechial hemorrhages in the eyelids and/or the conjunctivae, because these are a strong indication of massive compression of the neck such as strangulation or throttling.

The age-estimation of wounds can be performed on autopsy materials by histological and/or immunohistological procedures [3, 4]. However, at physical examinations, it must be carried out only with the naked eye. In a living person, the wound healing process is initiated immediately after injury and also continues during physical examinations, and a time-interval of undue length will allow changes such as reddenings and/or bruises caused by the alleged event to heal almost or completely. Furthermore, new injuries unrelated to the event may be sustained. Therefore, it is of great importance for the evaluation of a causal relationship between observed findings and the alleged event whether the appearance of the detected findings is in accordance with the time-interval after the alleged event as reported [5]. Although the age-estimation of bruises is described in the forensic literature [6–9], there are only few studies focusing on the time-dependent appearance of skin reddenings or petechiae in the eyelids and/or conjunctivae under medico-legal aspects [10]. Therefore, a retrospective study was performed on skin

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reddenings and also petechial hemorrhages in the eyelids and/or the conjunctivae observed at physical examinations.

Materials and methods

During the period 1993–1995, a total of 739 forensic physical examinations (1993: $n = 227$; 1994: $n = 281$; 1995: $n = 231$) of victims or assailants in cases of sexual assault, physical abuse, attempted homicide or homicide (only accused person) were carried out at the Department of Legal Medicine, University of Munich. Based on the report of the physical examination, the localization of reddening and the postinflation interval (P_i) were investigated. In every case with reddening in the neck region, it was also examined whether petechial hemorrhages were present in the eyelids and/or the conjunctivae.

Reddenings with additional changes such as pinpoint intracutaneous hemorrhages and/or minute superficial scratches or reddenings without additional changes were evaluated as a positive finding; reddenings associated with apparent hemorrhages (not pinpoint hemorrhage), deep abrasions and/or swelling, or reddenings by other stimuli (thermal or electrical injuries) except blunt or tangential forces were not evaluated. Furthermore, in each positive case, the P_i was carefully investigated and any cases with positive results but without an apparent causal relationship with the alleged event were also excluded.

Results

Among the 739 cases, 165 (22.3%) had positive results which were apparently related to the alleged event (reddening with additional changes: $n = 81$; reddening only: $n = 84$). Of the 81 cases of reddening with additional changes, 30 involved the neck, 23 the trunk, 16 the upper limb, 6 the head or the face, and 6 the lower limb. Out of 84 cases showing reddening without additional changes, 34 involved the neck, 19 the trunk, 15 the upper limb, 12 the head or the face, and 4 the lower limb. The results are listed in Table 1.

The postinflation intervals are summarized in Figs. 1 and 2. In 69 of the cases showing reddenings with additional changes, P_i was ≤ 1 day, 8 cases had P_i between 1 and 2 days, and in the remaining 4 cases, P_i between 2 and 3 days were observed. The maximum P_i in which positive findings occurred was almost 3 days, and these reddenings showing also pinpoint intracutaneous hemorrhages were localized on the trunk.

Table 1 Localization of the reddening with or without additional changes (pinpoint intracutaneous hemorrhages, minute superficial scratches)

Region	Reddening with additional changes n (%)	Reddening without additional changes n (%)
Neck	30 (37.0)	34 (40.5)
Head or face	6 (7.4)	12 (14.3)
Trunk	23 (28.4)	19 (22.6)
Upper limb	16 (19.8)	15 (17.8)
Lower limb	6 (7.4)	4 (4.8)

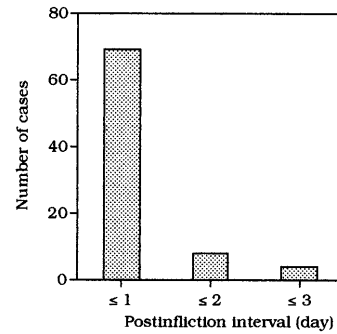


Fig. 1 The postinflation interval in skin reddenings with additional changes (superficial abrasions and/or pinpoint hemorrhages)

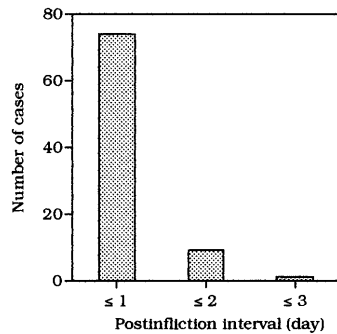


Fig. 2 The postinflation interval in skin reddenings without additional changes (superficial abrasions and/or pinpoint hemorrhages)

In 74 cases with reddening only the P_i was ≤ 1 day, and 9 cases had P_i between 1 and 2 days. The maximum P_i in which positive results were observed was 2 days and 13 h, and reddenings without additional changes were detected on the neck.

Out of the 64 cases in which the reddenings were detected on the neck, petechial hemorrhages of the eyelids and/or conjunctivae were seen in 17 cases (reddening with additional changes: $n = 10$; reddening only: $n = 7$). The maximum P_i in which petechial hemorrhages were detectable in the eyelids and/or the conjunctivae was 1 day and 21 h.

Discussion

Reddening of the skin is one of the most significant findings for forensic physicians which are commonly encountered in physical examinations of victims of sexual assaults, attempted homicides etc. [1, 2]. The reddenings are a result of mild, blunt or tangential forces which have acted directly or indirectly on the skin or near the site where they are observed. The characteristics of the surface of an object are sometimes imprinted as patterned reddenings on the skin. Such reddenings are likely to occur when an object with alternating ridges and grooves (eg. rubber soles of trainer shoes) impacts against the skin, as the skin will be forced into the grooves and sharply distorted [8]. Reddenings will occur here, and

the area in contact with the raised ridges may remain pale.

Skin reddenings can also be caused easily and unconsciously in daily life. One of the most important questions for forensic physicians is, therefore, whether the reddenings observed at physical examination are in accordance with the postinflation interval reported for the alleged event. It is important to evaluate whether the nature and the localization of the reddening are consistent with police reports and/or statements of persons concerned.

As the first aspect for the development, skin reddenings can be explained by one of the four cardinal signs of inflammation such as redness (rubor), heat (calor), pain (dolor) and swelling (tumor), which the roman Celsus described about 2000 years ago. Redness (reddening) is the first response during inflammation due to a variety of noxious stimuli. These four signs of inflammation result from reactions of the small blood vessels in the injured tissue. Immediately after injury, there is an inconstant and transient vasoconstriction of the arterioles feeding the damaged site by both neurogenic and chemical mediator systems, which usually appears within seconds to minutes [11]. After the transient vasoconstriction, vasodilatation by alterations in the tone of arteriolar smooth muscle and opening of pre-capillary sphincters occurs, and the blood flow at the injured site is greater than before injury resulting in hyperaemia. The increase of the blood flow can be observed as skin reddening [11, 12]. In addition, an increase in the permeability of venules, which allows leakage of fluid from the intravascular compartment into extravascular spaces, leads to swelling of soft tissue [11]. Chemical mediators play an important role in the vascular changes. Prostacyclin is the most potent vasodilator of all known prostaglandins but is an unstable compound. The stable prostaglandins of the A, D and E classes also cause vasodilatation resulting in reddenings of the skin [13]. Histamine derived from mast cells is also one of the vasodilators, and, in addition, increases vascular permeability of the venules [11, 14]. If reddenings result from only hyperaemia, all reddenings should turn pale on compression but this does not always completely. Therefore, as the second aspect for the development of reddenings, it is considered that diffuse intradermal (not subcutaneous) hemorrhages are also detected as reddenings in physical examinations. Reddenings resulting from intradermal hemorrhages, of course, require greater external force than those from only hyperaemia.

A previous report [10] and the present study show that the most common site where reddenings were found was the neck region followed by the trunk. These results suggest that the neck or the trunk region should be examined most carefully and intensively.

Evaluating the maximum postinflation interval in which positive results were detected, it could be recorded that the maximum *Pi* of reddenings with additional changes such as pinpoint hemorrhages and that of reddenings only were almost 3 days, and 2 days and 13 h, respectively. As expected, reddenings with additional changes are detectable for longer than reddenings without pinpoint hemorrhages

or superficial scratches since it is easily conceivable that the healing process of these additional changes indicating a comparably more intensive trauma represents a greater time-interval when compared to hyperaemia resulting from vasodilatation. As already reported in a previous study [10], it can be assumed that the reddenings with additional changes and reddenings only are found up to approximately 3 and 2 days after the event, respectively.

Petechial hemorrhages in the eyelids and/or the conjunctivae are also very important signs of compression on the neck. This assumption is confirmed by our observation that petechial hemorrhages in the eyelids and/or the conjunctivae were found in 17 out of 64 cases with skin reddenings in the neck. The development of petechial hemorrhages in the eyelids and/or the conjunctivae depends on the site, the degree and the duration of compression on the neck. In compression of the neck such as strangulation or throttling, occlusion of the jugular veins prevents venous drainage from the head, while the arterial supply from the more deeply placed carotid and vertebral arteries almost always continues [8]. There is, therefore, a rapid rise of venous pressure in the head, leading to engorgement of the veins in the eyelids and/or the conjunctivae. Furthermore, it is described that a ligature with a tension of 2 kg succeeds in occluding the jugular vein [8], and that the neck compression is required to continue at least for 30 s [15]. It is, therefore, considered that one or more of these 3 conditions were not satisfied fully in 47 cases with reddenings in the neck but without petechial hemorrhages in the eyelids and/or the conjunctivae.

Concerning the time-dependent appearance of petechiae in the eyelids and/or the conjunctivae in non-fatal asphyxia, Haba and Okamoto [16] reported a case in which petechiae in the face and ecchymoses in the bulbar conjunctivae could be seen up to 2 and 12 days, respectively. Ishizu [17] also performed a physical examination of a non-fatally throttled victim 15 h, 4 days, 1 and 3 weeks after the event and reported that petechiae in the eyelids and those in the palpebral conjunctivae were detectable up to 4 days and 1 week, respectively. In the present and a previous study [10], the maximum *Pi* in which petechial hemorrhages were detectable in the eyelids and/or the conjunctivae was 1 day and 21 h, and 2 days and 19 h, respectively. It is considered that the time interval when petechial hemorrhages are detectable depends on the number induced by neck compression. The results, however, mean that petechial hemorrhages in the eyelids and/or the conjunctivae which have occurred by compression on the neck can also be detected at physical examinations performed within 2 or 3 days after the event.

References

1. Härm T, Rajs J (1981) Types of injuries and interrelated conditions of victims and assailants in attempted and homicidal strangulation. *Forensic Sci Int* 18: 101–123
2. Kleemann WJ, Windus G, Roelfs T, Tröger HD (1990) Ergebnisse rechtsmedizinischer Opfer/Täter-Untersuchungen nach Sexualdelikten. *Arch Kriminol* 185: 19–25

3. Betz P (1994) Histological and enzyme histochemical parameters for the age estimation of human skin wounds. *Int J Legal Med* 107: 60–68
4. Betz P, Eisenmenger W (1996) Morphometrical analysis of hemosiderin deposits in relation to wound age. *Int J Legal Med* 108: 262–264
5. Naeve W, Lohmann E (1973) Methodik und Beweiswert körperlicher Sofort-Untersuchungen lebender Personen nach Straftaten. *Z Rechtsmed* 72: 79–99
6. Stephenson T, Bialas Y (1996) Estimation of the age of bruising. *Arch Dis Child* 74: 53–55
7. Langlois NEI, Gresham GA (1991) The ageing of bruise: a review and study of the colour changes with time. *Forensic Sci Int* 50: 227–238
8. Knight B (1996) *Forensic Pathology* 2nd edn. Edward Arnold, London Sydney Auckland
9. Polson CJ, Gee DJ (1984) *The essentials of forensic medicine* 3rd edn. Pergamon Press, Oxford, pp 103–110
10. Betz P, Eisenmenger W (1993) Zur Nachweisbarkeit von Hautrötungen beim Lebenden. *Arch Kriminol* 192: 80–86
11. Turner NC (1992) The response to injury. In: McGee J, Isaacson PG, Wright NA (eds) *Oxford textbook of pathology Vol 1*. Oxford University Press, Oxford New York Tokyo, pp 351–365
12. Zweifach BW (1964) Microcirculatory aspects of tissue injury. *Ann NY Acad Sci* 116: 831–838
13. Heggors JP, Robson MC (1989) Eicosanoids in wound healing. In: Watkins WD (ed) *Prostaglandins in Clinical Practice*. Raven Press, New York, pp 183–194
14. Cashley-Smith JR (1979) The fine structure of the microvasculature in inflammation. *Bibl Anat* 17: 36–53
15. Camps FE (1973) *Gradwohl's Legal Medicine* 2nd edn. John Wright & Sons Ltd, Bristol, p 341
16. Haba K, Okamoto K (1983) Petechial hemorrhages and abrasions due to non-fatal manual strangulation (in Japanese with English abstract). *Prac Res Forensic Med* 26: 97–100
17. Ishizu H (1982) A case of nonfatal manual strangulation (in Japanese with English abstract). *Act Crim Japon* 48: 9–12