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## Skin tears away from the entrance wound in gunshots to the head

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**Abstract** The present investigation covers 116 contact shots to the head and shots into the mouth from the Freiburg forensic autopsy material including 20 gunshot wounds which showed stretchmark-like tears of the facial skin away from the entrance wound. In these cases the gunshot entrance wounds were localised either in the mouth, the forehead, or the submental region. The stretchmark-like tears were found in the region of the eyes and the nasolabial folds. Radial tears were seen on the lips and in the vicinity of the corners of the mouth, particularly in cases involving shots into the mouth. The stretchmark-like tears essentially followed the skin tension lines and the expression-related lines of the face. They were apparently caused by the subcutaneous or intraoral expansion of the muzzle gases and/or the radial forces of the bullet resulting in ballooning and overextension of the facial soft tissues. The weapons used were not only rifles and shotguns, but also revolvers and pistols.

**Keywords** Stretchmark-like skin tears · Contact shots · Shots to the head · Intraoral shots

### Introduction

In wound ballistics, skin tears due to overstretching are often found in stellate entrance wounds after contact shots to regions with underlying bone [5, 16, 19]. In distant shots, radiating tears may occur if the bullet strikes at an acute angle [5, 8, 16, 19] or hits the body with an especially high velocity [5]. Short radial wound slits are also seen in bullet entrance wounds of the palmar and plantar skin [5, 15]. The slit-like or stellate appearance of gunshot exit wounds can also be attributed to local overstretching.

Several reports have been published on stretchmark-like skin tears which were not connected with the gunshot

entrance or exit wound. Krauland [13] found stretchmark-like tears on the chin, lips and cheeks after a submental contact shot from an infantry rifle. Grellner and Wilske [7] reported on a suicide committed with a walking-stick shotgun. After a shot against the floor of the mouth with a steeply ascending bullet track, superficial stretchmark-like tears were found in the inner angle of the left eye, while the right eye was destroyed.

Schaefer [18] stated even a century ago that intraoral shots may cause cut-like wound slits radiating from the mouth. In the atlas by Prokop and Radam [17] two intraoral shots inflicted by carbines are shown with radial tears of the lips and cheeks. Similar observations have been reported by Spitz [19] and DiMaio [5].

Karger and Banaschak [9] documented a contact shot to the forehead with a Brenneke-type shotgun slug which caused isolated stretchmark-like tears in the vicinity of the inner angles of the eyes.

Thurner and Pollak [22] presented a case in which a 6.35 mm bullet, after leaving the skull, followed a tangential course along the inner side of the galea aponeurotica thus causing shallow tears in the covering skin. Stretchmark-like tears may also form on other parts of the body, if the bullet path runs just under the surface of the skin [5, 14].

In this paper the frequency, conditions of formation and morphology of stretchmark-like skin tears away from primary gunshot injuries to the head were investigated in a larger number of consecutive cases from forensic autopsy material.

### Material and methods

The evaluation included 114 consecutive deaths from the forensic autopsy material of the Freiburg Institute of Legal Medicine with contact shots to the head or shots into the mouth. Of these cases 111 were suicides and 3 cases were homicides. As two of the suicides had each fired two shots to the head, the total number of hits was 116.

Following the usual procedure in the investigation of deaths due to gunshots [5], an X-ray examination was first carried out. After the collection of evidence and cleaning of the bodies, the wound morphology was recorded and documented by photographs. Where

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**Table 1** Summary of the shots to the head and into the mouth associated with stretchmark-like tears of the facial skin

No.	Entrance site	Age (years)	Sex	Firearm	Additional fractures of the skull	Localisation of the stretchmark-like tears	Remarks
1	Mouth	73	m	Nagant revolver, cal. 7.62 mm	Fractures of the calvaria and skull base	Lips, both corners of the mouth	[2]
2	Mouth	59	m	Walther P5 pistol, cal. 9 mm	Fractures of the calvaria and skull base	Lips	
3	Mouth	39	m	Walther P5 pistol, cal. 9 mm	Fractures of the calvaria and skull base	Lips, right corner of the mouth	
4	Mouth	21	m	Smith & Wesson revolver, cal. .44 Magnum	Fragmentation of the calvaria and skull base	Lips	
5	Mouth	61	m	Old muzzle-loader pistol	Fragmentation of the calvaria and skull base	Lips, both corners of the mouth	
6	Mouth	25	m	Kalashnikov assault rifle, mod. AK 47, cal. 7.62×39 mm	Bursting of the bony skull	Upper lip, root of the nose on both sides, inner angles of the eyes	Fig. 3
7	Mouth	40	m	Swiss military rifle, cal. 7.5×55 mm	Bursting of the skull with complete loss of the brain	Radial tears of the lips, nasolabial folds	Fig. 1
8	Mouth	63	m	Hunting rifle, cal. 8×57 mm	Bursting of the skull with partial loss of the brain	Upper lip, both corners of the mouth, cheeks on both sides, nasolabial folds, glabella, inner and outer angle of the left eye, left upper lid, region in front of right earlobe	Fig. 2
9	Mouth	45	m	Sawn-off shotgun, cal. 16, pellet size 4.5 mm	Bursting of the bony skull, rupture of the nasal ridge	Right corner of the mouth, right cheek, right nasolabial fold, inner angle of the left eye, both lids of the right eye	
10	Mouth	38	m	Shotgun, cal. 16, pellet size 3.5 mm	Bursting of the bony skull, rupture of the root of the nose	Lips, right upper lid	
11	Forehead	30	m	Ruger revolver, cal. .357 Magnum	Fractures of the skull base	Right inner angle of the eye, right upper lid	
12	Forehead	22	m	Python revolver, cal. .357 Magnum	Fractures of the skull base and calvaria	Both inner angles of the eyes	
13	Forehead	49	m	Smith & Wesson revolver, cal. .38 Special	Fractures of the skull base and calvaria	Both inner angles of the eyes	
14	Forehead	83	f	Military carbine SIG, mod. K 31, cal. 7.5×55 mm	Bursting of the skull without exenteration of the brain	Along wings of the nose	Homicide
15	Forehead	54	m	Military carbine SIG, mod. K 31, cal. 7.5×55 mm	Bursting of the skull without exenteration of the brain	Left upper lid, along left wing of the nose	
16	Forehead	56	m	Hunting rifle, cal. 8×57 mm	Bursting of the skull with exenteration of the brain	Left inner angle of the eye	
17	Forehead	84	m	Hunting rifle, cal. 8×57 mm	Bursting of the skull with exenteration of the brain	Around the eyes, nasolabial folds	Fig. 4
18	Submental region	81	m	Walther PP pistol, cal. 7.65 mm	No fractures of the calvaria; exit wound outside the cerebral cranium	Lower lip	[6]
19	Submental region	43	m	Repeating rifle Mauser, mod. 98k, cal. 8×57 mm	Bursting of the skull with partial loss of the brain	Laryngeal region, along right wing of the nose	
20	Submental region	35	m	Shotgun, cal. 12 (cartridge with Brenneke type slug)	Bursting of the skull without exenteration of the brain	Both sides of chin and cheeks, nasolabial folds, both inner angles of the eyes	

the gunfire had caused bursting of the skull, additional reconstructive measures were required [20]. If the loss of cranial bones was considerable, the contour of the skull was restored by inserting pulp and gaping soft tissue lacerations were approximated in their natural position by using sutures. Where post-mortem drying had occurred, suturing was made possible after moistening the wound margins for several hours. Thus the location of the entrance and exit wound, the direction of fire and the presence of secondary injuries, if present, could be visualised. Moreover victims of unclear identity could be subsequently identified by relatives after reconstruction of the facial soft tissue.

## Results

Of the 116 contact and intraoral shots, 20 cases (17.2%) showed additional skin tears due to overstretching away



**Fig. 1** Stretchmark-like tears beside the wings of the nose and radial tears of the lips and the corners of the mouth after a shot into the mouth (Swiss military rifle, cal. 7.5×55 mm)

**Fig. 2** Stretchmark-like tears along the nasolabial creases and at the corners of the mouth with fan-like radiation into the cheek area after a shot into the mouth (hunting rifle, cal. 8×57 mm)



from the entrance wound localised in the oral cavity ( $n=10$ ), forehead ( $n=7$ ) and submental region ( $n=3$ ). After shots from carbines, hunting rifles or shotguns, bursting of the skull (with or without exenteration of the brain) was present in most cases. In our study material contact shots to the temporal, parietal and occipital region were not associated with distant stretchmark-like tears.

In shots from standard .22 rimfire weapons and .25 handguns, no stretchmark-like tears could be observed. On the other hand in cases without such tears ( $n=96$ ), 40 shots were fired from weapons of calibre .22 or .25.

In Table 1 the shots to the head associated with stretchmark-like tears of the facial skin are briefly described according to the localisation of the entrance wound. With one exception (no. 14) all shots were fired with suicidal intent.

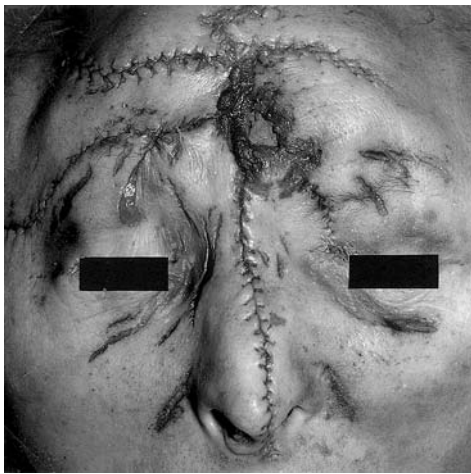
## Discussion

In the study material showing stretchmark-like tears away from the entrance wound, the preferred localisations of these tears were, in decreasing order of frequency, the lips and corners of the mouth (Figs. 1 and 2), the skin around the eyes (Figs. 3 and 4), the nasolabial folds (Figs. 1, 2 and 4) and the cheeks (Fig. 2). A cumulative graph of the local distribution of all lesions is given in Fig. 5.

The contact shots to the head and intraoral shots showing separate stretchmark-like skin tears had the following features in common:

- The entrance wounds were located approximately in the median plane (forehead, mouth, submental region)
- The skin tears due to overstretching generally followed the skin tension lines or primary folds of the face; periorally they showed a radial arrangement

**Fig.3** Stretchmark-like tears at the inner angles of the eyes and on both sides of the root of the nose after a shot into the mouth (Kalashnikov assault rifle, cal. 7.62×39 mm)

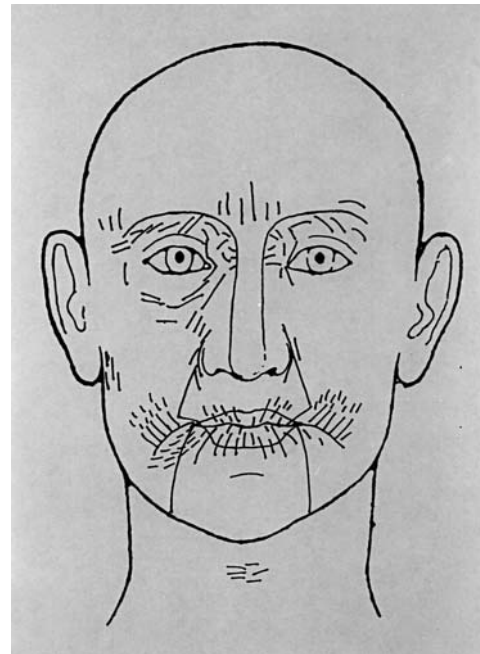


**Fig.4** Stellate entrance wound after a contact shot to the forehead (status after soft tissue reconstruction). Stretchmark-like tears around the eyes and in the nasolabial folds (hunting rifle, cal. 8×57 mm)

- The weapons had not been fired using standard .22 rim-fire cartridges or .25 Auto (ACP) cartridges.

A characteristic feature of contact shots is that the muzzle is tightly pressed against the skin and the powder gases penetrate into the body and expand. The expansion potential of muzzle gases is illustrated by the observation that a contact shot from a rifle to the abdomen may result in an overexpansion of the entire abdominal wall [5]. Accordingly, a rapid increase of volume within the soft tissue of the face also leads to overexpansion [5, 19] resulting in skin tears of varying depth in the zones of maximum tension and/or low elasticity. The radial forces transmitted by the projectile further increase the centrifugal acceleration and overstretching of the tissue.

Stretchmark-like tears as secondary lesions of intraoral and contact shots to the head, are indirect injuries where the location and appearance are also influenced by the anatomical structure of the affected tissue. It is generally known that the elasticity of the skin depends on the



**Fig.5** Cumulative diagram of the stretchmark-like tears observed in 20 gunshot wounds of the study material

arrangement of the collagen fibres of the dermis [4, 24]. The elasticity of collagen fibres along their longitudinal axis is low, but as they consist of transversely cross-linked fibrils, they are able to expand parallel to the skin surface in a trellis-like way. Stretching of the skin increases the lateral distances between the collagen fibres. The tensile stress is transferred to the epidermis which, starting from its topmost layer tears along the course of the micro-anatomical fibre gaps of the corium. The result is a typical pattern of small, wavy, grouped tears due to overstretching following the skin tension lines (cleavage lines) [4].

The skin of the face is particularly thin, mobile and elastic, and its subcutaneous tissue has a very loose texture [23]. In addition the superficial facial fascia is well developed only on the lateral parts of the face (fascia

parotideo-masseterica), whereas the frontal region of the face (regio faciei anterior) has no fascia at all [23]. The paramedian areas of the face are therefore particularly susceptible to tears due to overstretching, especially if the entrance sites of the bullets or pellets are also localised in this area, as in the reported cases.

Just like the cutaneous tension lines, the muscles of facial expression also determine the direction in which the skin will tear on overstretching with the lacerations usually being located at right angles to the relevant facial muscle fibres [3]. Correspondingly, radial tears of the lips are found after overstretching of the orbicular muscle of the mouth (cf. Fig. 1).

In contact shots to the forehead the muzzle gases expand centrifugally between the frontal squama and the skin. Under these circumstances stretchmark-like tears are typically located around the eyes (especially the inner angles), also after rifle shots to the forehead in the paranasal region (cf. Fig. 4).

Steeply ascending bullet tracks or those running closely below the surface of the facial soft tissue, e.g. after submental shots and shots into the hard palate, may cause stretchmark-like tears at different locations. In such cases tears may occur on the lips, cheeks, nasolabial folds and angles of the eyes. A shot in the submental region or the mouth with radial tears of the lips suggests that the mouth was shut at the time of firing. Due to the radial expansion of the muzzle gases and the analogous anatomical structure on both sides of the face, the stretchmark-like tears in contact shots are often arranged symmetrically to the median plane of the head (cf. Figs. 2 and 3).

Among the contact shots fired to the forehead and the submental region as well as the intraoral shots, stretchmark-like tears away from the entrance wound could be demonstrated only in about half of the cases. Their absence was possibly due to the following reasons: insufficient energy of the ammunition (e.g. standard .22 rimfire and .25 Auto cartridges), holding the muzzle loosely against the skin and/or at an oblique angle (so that part of the powder gases could escape laterally). As for intraoral shots the lips may not have been tightly closed around the muzzle.

Complex findings in gunshot injuries often require the additional use of special imaging methods such as CT and MRI [10, 21] or other modern techniques (e.g. DNA analysis of tissue deposits on spent bullets [11]). On the other hand the mere look of an expert may sometimes be enough to solve the case, as Bajanowski et al. [1] recently showed in a case report. The same applies to the knowledge of a simple finding such as stretchmark-like skin tears located away from the entrance wound.

As is well known, the face belongs to those body regions which are prone to lacerations from direct blunt trauma, as the skin and subcutaneous tissue lie over the bony platform of the skull and are crushed against it when the force impacts [12]. Lacerations of the facial skin can resemble incised wounds as well, so it seems justified to call the forensic pathologist's attention to the stretchmark-like skin tears in order to prevent errors on the alleged presence of additional trauma not related to gunfire.

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