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SIR STEWART DUKE-ELDER

VOL. XIV

INJURIES

PART 2

NON-MECHANICAL INJURIES

By

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SECTION II

NON-MECHANICAL INJURIES

THERMAL, ULTRASONIC, ELECTRICAL, RADIATIONAL, CHEMICAL and STRESS INJURIES

FIG. 691.—AUGUST WAGENMANN.
[1863–1955].

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THERMAL INJURIES

If Ramazzini were the ideal choice to introduce the first Section in this book, it would seem logical to preface the second part with the portrait of the master who contributed so lavishly to the consolidation of our knowledge of this subject. Indeed, no treatise on ocular injuries could be complete without the payment of a tribute to AUGUST WAGENMANN [1863–1955] (Fig. 691), Professor of Ophthalmology in Jena (1892) and then in Heidelberg (1910). For many years he assumed primary responsibility for the conduct of the German Ophthalmological Society and also acted as senior editor of von Graefe's *Archiv für Ophthalmologie*. His greatest and most sustained professional interest, however, was the subject of ocular injuries in all their aspects. To our knowledge of this branch of ophthalmology he added a continuous succession of original observations throughout his life, but we are most deeply in his debt for his masterly treatises on this subject comprising two volumes in the second (1910–13) and three in the third (1915–24) edition of the Graefe-Saemisch *Handbuch der gesamten Augenheilkunde*—writing which has rarely been equalled in its comprehensiveness, the acuity of its judgment and the soundness of its criticism.

In this chapter we propose to deal with injuries to the eyes and their adnexa caused by extreme variations of temperature, such as are associated with thermal burns and freezing or exposure to cold.

HYPERTHERMAL INJURIES

Neglecting for the moment burns caused by radiant energy,[1] ultrasonic injury[2] and electricity[3] in which the effects of a high temperature are involved, THERMAL BURNS can be divided into two types—FLAME BURNS and CONTACT BURNS due to hot bodies or fluids (scalds). The pathological basis of the two types of injury is similar, but in a clinical discussion the separation of the two is justified by the difference in their clinical effects, for the first rarely involves the eye itself directly, while the second may well do so.

FLAME BURNS

FLAME BURNS involving the face are common. In Great Britain, where the very pleasant open coal fire is still a popular method of domestic heating in some areas, almost two-thirds of serious burns occur in the home,[4] caused in the main by clothing catching fire or—an accident usually involving injuries of a very serious nature—a child or an epileptic actually falling into the fire itself (Figs. 692; 706). The explosion of a stove or gas-heater can be

[1] p. 837. [2] p. 801. [3] p. 813.

[4] In England and North America, between 60 and 90% of all deaths due to burns and scalds result from accidents in the home (W.H.O., 1967).

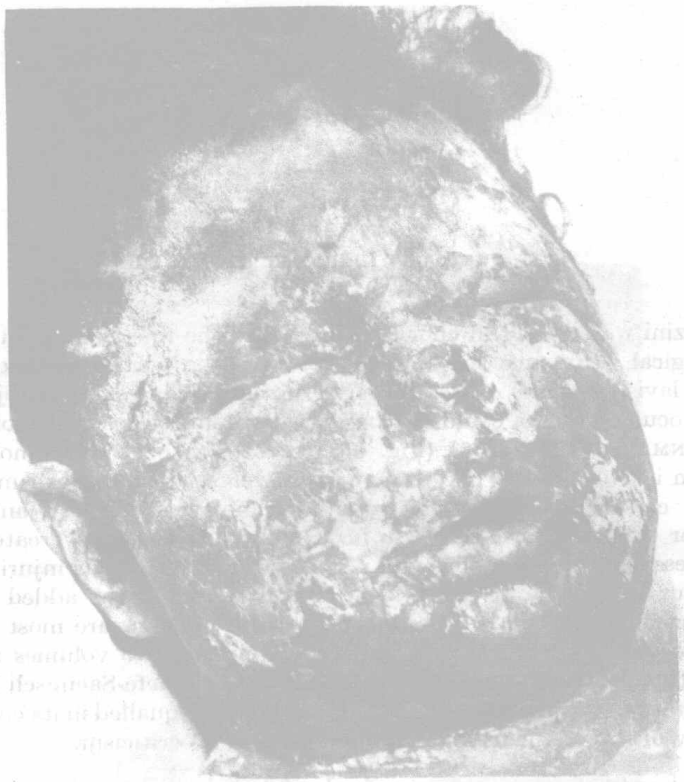

FIG. 692.—FLAME BURN OF THE FACE.

Photograph taken on the second day after burning, showing the gross œdema of the lids so that the eyes cannot be opened, and of the lips so that drinking is almost impossible (Douglas Jackson, Birmingham Accident Hospital).

FIG. 693.—FLAME BURN OF THE FACE.

At a later stage than Fig. 692, showing the formation of granulations. The burn was incurred by setting fire to some straw. The skin of the face and lower lids was destroyed to a considerable depth; the eyes escaped damage (T. Pomfret Kilner).

FIG. 694.—GUNPOWDER BURN OF THE FACE AND EYELIDS (M. M. Baltin).

equally dangerous. The remainder of civilian cases comes from industry, where high temperatures and inflammable fluids are common, gases, ovens, furnaces or petrol stores are liable to explosion, or oil-soaked overalls constitute a hazard, while a burning building wherein people are trapped sometimes claims casualties of this type. So also do accidents in travel, in automobiles, trains, ships or airplanes. In war the flame-thrower, the napalm bomb, or an explosive fire in the confines of a tank on land, a burning plane in the air, an explosion in the gun-turret of a ship or the tragedy of swimming through boiling or burning oil floating on the sea, the incendiary bomb or the inferno of a burning city in civilian air-raids[1]—all these add their toll and multiply a thousand-fold the hazards of peace (Figs. 693–4).

FIG. 695.—CORDITE BURN OF THE FACE.

A third degree burn leading to full-thickness skin-loss. Incurred in a ship in the Battle of Jutland, 1916 (C. P. G. Wakeley, from Hamilton Bailey's *Surgery of Modern Warfare*).

FIG. 696.—PHOSPHORUS BURN.

Due to an incendiary bomb (C. P. G. Wakeley, from Hamilton Bailey's *Surgery of Modern Warfare*).

Of the more common of these, petrol burns—frequent both in peace and war—are usually deep and extensive owing to the fact that petrol-soaked clothing, once alight, is difficult to extinguish (Figs. 700–703). Flash burns from an explosion in a confined space, on the other hand, such as the cordite burns in the gun-turret of a ship or in a tank, or as occasionally occur in munition works, are mostly extensive and superficial, involving the face and hands (see Figs. 695, 784–6). Particularly if such an injury is due to a bomb-flash, the burn may be complicated by other injuries and lacerations due to blast which sometimes causes small multiple lesions deep into the skin (Figs. 697–9).

[1] For example, in the second World War, 85 square miles of buildings in the city of Tokyo were burned to the ground in air-raids, involving the death of 96,000 people. In the U.S. Navy in peace-time 20% of the casualties are burns (Trexler, 1944), and these injuries constituted 60% of the total casualties in the Japanese attack on Pearl Harbor (Davis, 1944).

Although the age-distribution of cases of burns shows a wide variation according to the area and type of hospital concerned, nevertheless the incidence of accidental burns in children is considerable and important, not only because the majority could probably have been prevented but also because of the serious and often tragic functional, cosmetic and emotional disabilities which may ensue (Blocker, 1965; MacKeith *et al.*, 1968). In the series of 1,819 cases from the University of Texas (Table XXIII) 50% of the patients were under the age of 20, 2% occurred in infants under the age of 12 months, 20% were under 5 years of age and 36% were 10 years old or younger

FIGS. 697 to 699. Bomb-flash burn of the face (C. P. G. Wakeley, from Hamilton Bailey's *Surgery of Modern Warfare*.)

FIG. 697. FIG. 698. FIG. 699.

FIG. 697.—One hour after injury, showing singeing of the hair and brows and a superficial burn of the face, the skin of which is split by blast in many places.

FIG. 698.—Seven days after injury.

FIG. 699.—Fourteen days after injury.

(Blocker *et al.*, 1961; Lynch, 1968). Even in an industrial community two-thirds of head and neck burns occur as a result of accidents in the home and, of these, two-thirds are in children under the age of 5 years, although most of these are, in fact, scalds without actual ocular injury (in Birmingham, Jackson, 1965). It is to be remembered also that patients at the extremes of life tolerate burning poorly, the mortality rate being high under the age of 1 year, even when the burn involves only a relatively small area of the body-surface, and also over the age of 60; in cases of third-degree burns, therefore, the age of the patient and the extent of involvement of the body-surface are the two most important factors in an assessment of the prognosis for survival. Although it is true that many patients now survive who would otherwise have died during the early period of shock following the burn, a

significant proportion subsequently succumbs to the complications of toxæmia[1] involving infection and serious disturbances of the electrolyte balance of the blood.

It is interesting that the eyes themselves are rarely involved in a flame burn unless the heat is intense and prolonged; then, indeed, the lids may be destroyed, the cornea shrivelled, the ocular tissues damaged in varying degrees and, in the worst cases, the whole eye and the orbital contents incinerated.[2] Such cases, however, rarely survive. In the ordinary case the lashes and brows may be scorched, the skin of the lids deeply burned, and extensive and widespread injury may be done to the face and more widely over the body, but as a rule the reflex closure of the lids is sufficiently rapid to protect the globe and leave a white band of unburned skin around the palpebral fissure strangely isolated in a widely charred area. It is interesting also that, despite the delicacy of the skin of the lids, the tarsal plates usually

TABLE XXIII

ANALYSIS OF THE CAUSE IN 1,819 CASES OF BURNS

(Blocker *et al.*, 1961, and Lynch, 1968)

Cause	*Number of Cases*	*Percentage*
Flash and Flame	1,426	78·3
Scalds	218	12·0
Contact	86	4·7
Electrical	53	3·0
Chemical	32	1·8
Sunburn	4	0·2
Total	1,819	100·0

remain intact. Only when the flames spread with explosive force is the cornea damaged, and then, indeed, the scorching may be severe, resulting in destruction of the epithelium; even such damage, however, is generally superficial and epithelial regeneration usually occurs within 48 hours.

In this connection the figures of Tubiana (1967) are interesting: over a five-year period at the Burns Centre of the Hôpital Cochin in Paris, 900 cases were treated of which 290 had sustained injuries to the face either alone or in association with burns elsewhere, most commonly on the dorsum of the hand (118 cases). It would seem that the protective reflex frequently enables the victim to cover his face with his hands, thereby averting an oculo-palpebral burn. At East Grinstead between 1940 and 1950 out of 144 cases of facial burns involving the eyelids, the conjunctiva was involved in 37 and the cornea in 29 (Schofield, 1954), while in the succeeding years from 1950 to 1959 at the same centre among 220 cases of facial burns there were 50 with involvement of the eyelids, necessitating surgical repair (Romanes, 1959). Roper-Hall (1965) reported the results in 46 cases of thermal burns involving the eyes, for which hot metal was responsible in 17 cases and fireworks in 15; in 25 cases both eyes were injured; permanent corneal damage resulted to 24 eyes, while corneal necrosis and thinning occurred in 6 and symblepharon in 3 followed the entry into the eye of hot metal; in

[1] p. 757.

[2] Zander and Geissler (1864), Klunker (1907), Windel (1913), von Szily (1918), and others.