

## THE CARDIAC EFFECTS OF LIGHTNING INJURY

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Although thunderstorms are exceedingly common on the Witwatersrand, and as a consequence, deaths and injuries due to lightning are a fairly frequent occurrence, documentation of the clinical effects of lightning injury—especially cardiac injury—is exceedingly sparse. We report 2 such cases which survived.

### CASE REPORTS

#### Case 1

A 20-year-old female was struck unconscious when she sought shelter from a thunderstorm under 2 tall trees which were struck by lightning. She was one of a company of 33 persons sheltering under these 2 trees. Six were killed outright, 12 were treated in the casualty department and allowed to go home, and the remaining 15 were admitted.

The patient regained consciousness some hours after admission and exhibited marked retrograde amnesia.

The face and right wrist were swollen, and the conjunctiva of the left eye was congested. An irregular linear burn was present over the left breast (Fig. 1). Her back showed nume-

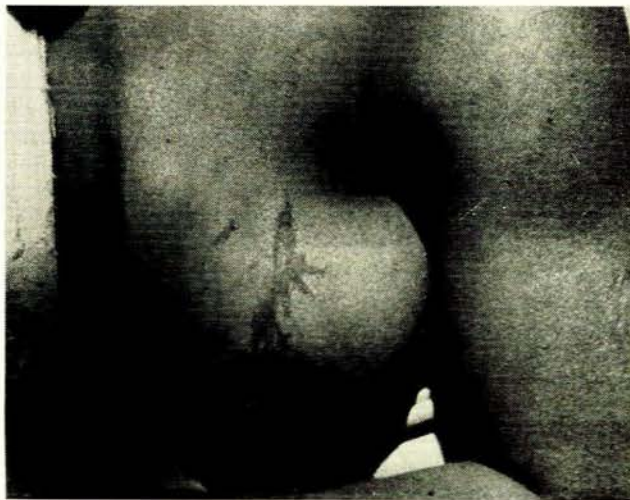


Fig. 1. Case 1. Illustration of typical arborescent burn of left breast pathognomonic of lightning injury

rous 'spidery' burns radiating from central small areas of superficial skin loss (Fig. 2). The pulse rate was 72 per minute and the blood pressure 115/70 mm.Hg. The rest of the clinical examination was essentially negative.

The electrocardiogram (Fig. 3) showed elevation with upward coving of the S-T segment in standard lead I, leads aVL and V1-V4. The S-T segment was depressed in stan-



Fig. 2. Case 1. Illustration of 'spidery' burns on back.

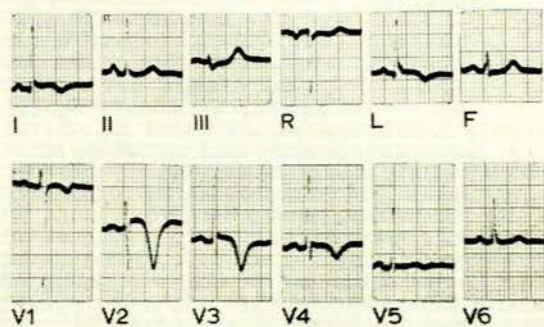


Fig. 3. Case 1. Electrocardiogram recorded on admission and showing anterior myocardial injury.

dard lead III and leads aVR and aVF. The T waves were inverted and symmetrical with an 'arrow-head' appearance in standard lead I, leads aVL and V1-V4.



There were no pathological Q waves or loss in height of the R waves. The appearance was consistent with fairly extensive epicardial damage over the anterior surface of the heart.

Investigation the following day showed the following: White cell count 17,500 cells/cu.mm; C-reactive protein 3 plus; serum glutamic oxalacetic transaminase activity 130 units/100 ml. (normal range 35-100).

Further progress and recovery were uneventful with eventual complete regression of all electrocardiographic changes (Fig. 4). The burns healed completely with only faint residual pigmentation.

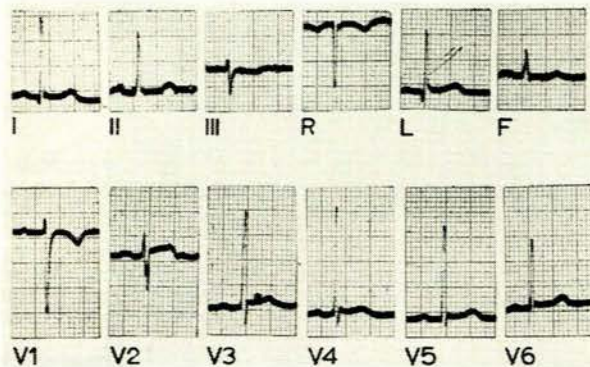


Fig. 4. Case 1. Electrocardiogram showing regression of abnormal features.

#### Case 2

A 30-year-old farm labourer was struck unconscious by lightning while working in a field. A friend stated that the flash hit the patient on the head, burning his hat. He regained full consciousness half-an-hour after admission to hospital and complained of deafness.



Fig. 5. Case 2. Illustration of skin burns. See text.

The hair was singed over the left occipital region; in addition, the skin of both groins, the left side of the neck, and the precordium, was scorched (Fig. 5). The pulse was 100 per minute and regular; the blood pressure was 130/90 mm.Hg. A presystolic gallop rhythm was present and persisted for a few hours. The rest of the physical examination was essentially negative.

The electrocardiogram (Fig. 6) showed elevation of the S-T segment, and inversion of the T wave in standard leads II, III and lead aVF, indicating inferior myocardial injury. All these electrocardiographic changes had regressed to complete normality by the 7th day.

Laboratory investigations on the second day showed the following: Serum glutamic oxalacetic transaminase activity 27 units/100 ml. (normal range 2-35); glutamic pyruvic transaminase 50 units/100 ml. (normal 2-35); lactic dehydrogenase activity 430 units/100 ml. (normal 100-280).

An electroencephalogram on the 5th day demonstrated diffuse non-specific mild abnormality. A repeat recording 10 days later showed distinct improvement with higher voltage and more rhythmical activity; there was, however, persistence of short bursts of O-activity at 6 cycles per second.

Recovery was uneventful. Normal hearing was gradually regained over a period of 1 week, and the burns healed completely.

#### DISCUSSION

Skin burns as well as loss of consciousness with retrograde amnesia are extremely common in cases of lightning injury.

These were characteristic features in both our cases.

A less common, though by no means infrequent feature, is transient deafness, which was also exhibited by both these cases. Indeed, there may be temporary or permanent neurological involvement which may manifest immediately or as a delayed phenomenon.

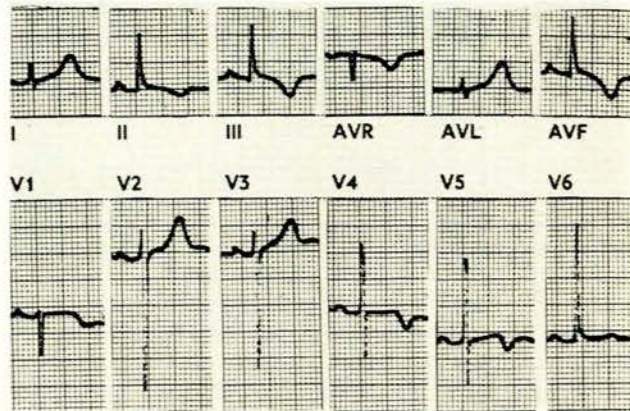


Fig. 6. Case 2. Electrocardiogram demonstrating inferior myocardial injury.

Both patients had extensive burns. The spidery or arborescent markings are believed to be due to the electrical discharge following pathways of dampness where the consequent electrical resistance of the skin is lowest.<sup>1</sup> A similar mechanism may well account for the skin burns which frequently occur under any metal object in contact with the body, e.g. keys and coins. Adjacent to such burns, there is a reorientation of the cells of the lower Malpighian layer of the skin into straight lines along the direction of the current—a feature that is pathognomonic of electric or lightning burns.<sup>2</sup>

The lightning probably struck the first patient at the site of the large burn over the left breast, travelled through and around the chest, and was finally dissipated over the back where the burn marks were spread over a wider area.

Experimentally, it has been found that the heart is particularly susceptible to the precipitation of ventricular fibrillation by a stimulus initiated soon after the absolute refractory period. Hence, a common cardiac cause of death in lightning injury is ventricular fibrillation.

The unusual manifestation of the present cases was the damage to the myocardium as evidenced by the electrocardiographic features of raised S-T segments and inverted T waves. Such demonstrable evidence of cardiac injury in surviving cases is extremely rare and has not to our knowledge been reported.

It should be noted that the value of enzyme studies is largely vitiated by the concomitant trauma to other tissues.

It is of interest that frank myocardial infarction following electric shock has been described but is rare,<sup>3</sup> and it is noteworthy that in some cases, the electrocardiographic changes developed as late as 4 weeks after the electric shock. As the current generally travels via the blood stream, Imboden and Newton<sup>3</sup> considered that this might cause endarteritis of the coronary vessels with subsequent superimposed thrombosis.

As already intimated, survival following cardiac damage by lightning must be rare, because the magnitude of an electrical discharge sufficiently severe to cause cardiac damage is far more likely to cause death.

#### SUMMARY

Two cases who survived being struck by lightning are described. In addition to concussion, and transient deafness, there was the unusual feature of electrocardiographic evidence of myocardial damage.

We wish to thank the Superintendent of Baragwanath Hospital for permission to publish the cases; Drs. L. Schamroth and H. E. Reef for interpretation of electrocardiograms and electroencephalograms, respectively; and the Photographic Unit, Department of Medicine, University of the Witwatersrand, for the photographs.

#### REFERENCES

1. Hughes, J. P. W. (1956): *Brit. Med. J.*, **1**, 852.
2. Jellinek, S. (1957): *Triangle*, **3**, 104.
3. Imboden, L. E. and Newton, C. B. (1952): *U.S. Armed Forces Med. J.*, **3**, 497.