

Lightning Metallization Injury

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CASE SUMMARY

We report the case of an unusual lightning-related phenomenon.

A 41-year-old male construction worker sustained a direct lightning strike, at approximately 16:00 SAST, in mid-November 2021.

Scene examination showed a large amount of mud, because of the rain, and remnants of torn-and-tattered clothing.

Autopsy examination showed an adult male with linear, longitudinally orientated scorch burns over the left side of the neck, front of the chest, left inguinal region, and inner aspect of the left thigh. The right eardrum was ruptured. There was singeing of the pubic hair. The clothing was torn and tattered and showed synthetic material melting at places. Internal organ examination proved nonspecific. Features were in keeping with the available history of a direct lightning strike.

The South African Lightning Detection Network detected a positive cloud to ground lightning strike with a peak current of 6 kA at 15:51:25.4 South African Standard Time (13:51:25.4 Coordinated Universal Time). The event was far away from the moving storm, indicating the “bolt from the blue phenomenon.”

Metal-chain-link-burns were present. It is this phenomenon that the authors would like to highlight in this article. The decedent was wearing blue denim jeans. The front of the denim jeans was covered with mud. There was a patch measuring 8 × 4 cm overlying the anterior aspect of the left thigh region, which showed tearing and tattering. Interestingly, the zipper on the front of the blue denim was damaged by lightning.

There was an area measuring approximately 10 x 7 cm overlying the anterior-lower aspect of the right side of the chest, which showed metal-chain-link-burn imprint marks. Multiple small metallic links (teeth from the exploded zipper) could be seen in relation to these small burn marks. Several of these links had melted and embedded into the skin.

Please refer Figures 1–5.



FIGURE 1. Lodox examination, showing the ruptured zipper.



FIGURE 2. Photograph of the anterior aspect of the chest and abdomen



FIGURE 3. Close-up photograph of the metal-chain-link-burn

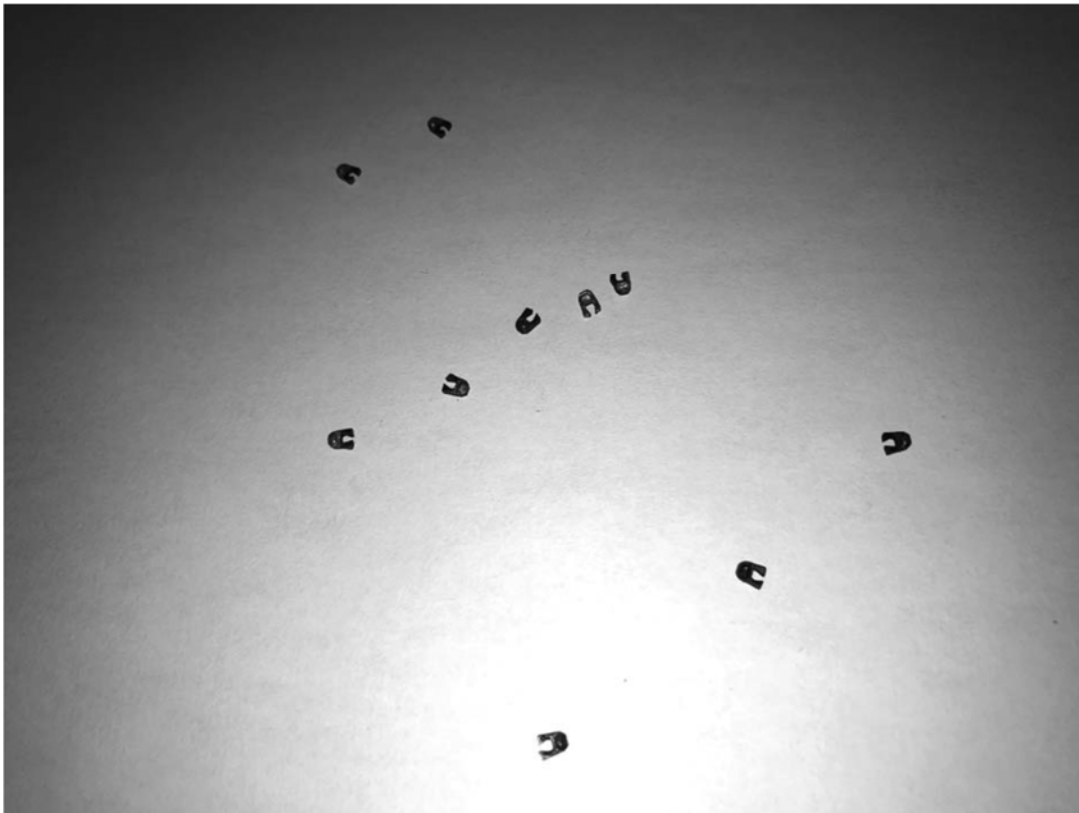


FIGURE 4. A photograph of the exploded "teeth" of the zipper

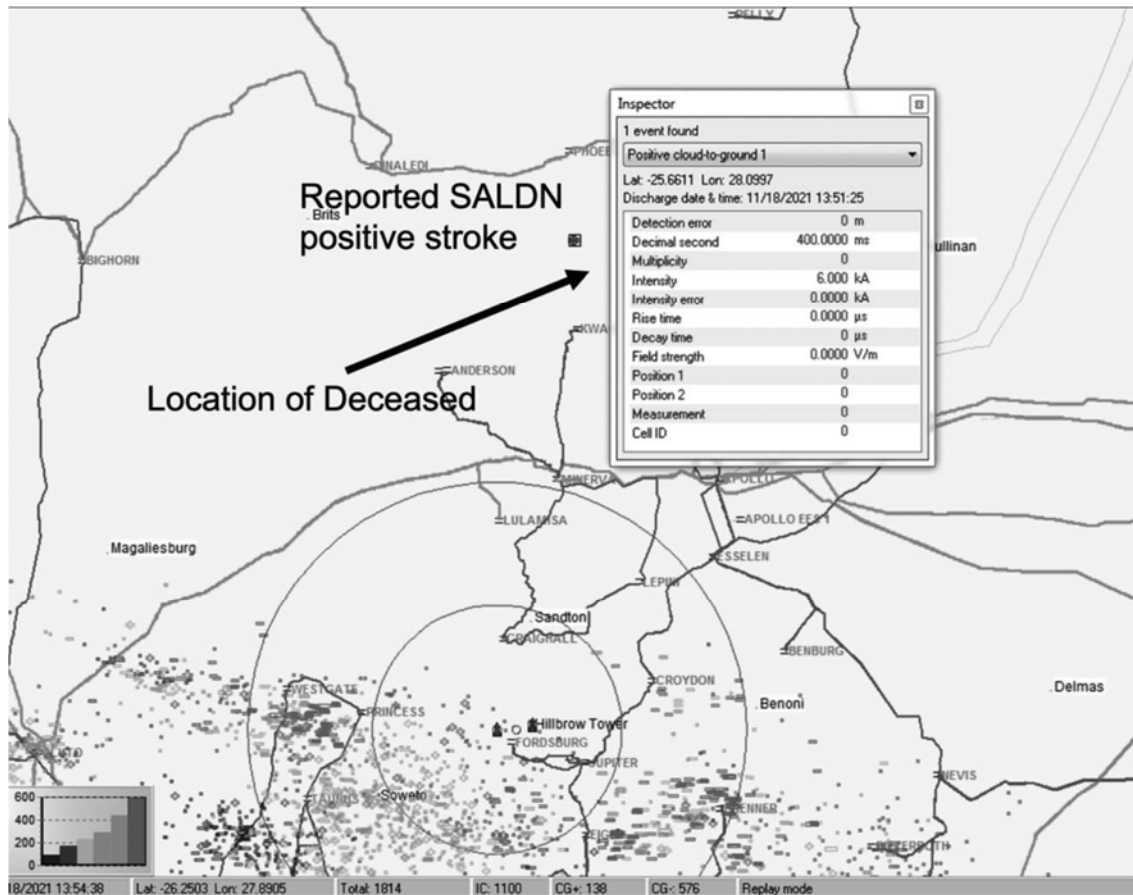


FIGURE 5. Reported SALDN lightning events on November 18, 2021. Positive 6 kA “bolt from the blue” reported stroke near the location of the deceased at the estimated time.

There are few published studies about this lightning metallization phenomenon in the literature, with only a few cases observed in Colombia.^{1,2} It is the purpose of this article to highlight this phenomenon and explain the theory as to how this possibly occurs.

DISCUSSION

In the event of a lightning stepped leader propagating toward a person, the head of the person typically acts as the streamer emitting point that connects the stepped leader tip and the ground (through the body). It is most probable that the streamer initiating point arises from the grounded footprint of the person. If the person is wearing an item containing metal, either as part of the clothing, or as metal jewelry, such as a necklace, or a zipper, it may act as a floating electrode that generates a bidirectional streamer.^{3,4} This bidirectional streamer enhances the streamer development process, because it bridges the head of the person and the grounded footprint more quickly. Thus, the lightning return stroke current most probably flows through the metal object dissipating sufficient heat energy to melt the metal item. In other words, the metal object retains the current for a greater period of time.

Note that the amplitude and temporal characteristics of lightning return stroke current have a large spectrum of values; thus, there may be cases where the lightning current is capable of melting the metal object and cases where it may not.

Most necklaces are not solid wire-like structures but are made of hundreds of loosely connected links. So too, the teeth of a zipper, also known as elements, act like connected links. It is likely that these wire links are made of different types of metals, with different melting points. Some metals may evaporate and others may not. Apart from the melting effect, the intense lightning current may create micro arcs across these links causing a sufficiently large mechanical force to rip the necklace, or zipper, into multiple fragments. This phenomenon may be seen as an explosion of the wire-linked metal item. The melted links suggest a thermal component to this phenomenon.

Separating (a) the wound from (b) the process occurring in the metal is important.

Previous terms used to describe the process in the metal have included “cuprification,” “zincification,” and “sublimation,” all have been used to describe this phenomenon. The correct name for this phenomenon, as related to lightning, is still open to debate, because there is no uniform terminology in the literature.

Regarding the wounds on the skin, it is proposed that lightning metallization injury may be the technically correct term.

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