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Agonal Sequences in Four Filmed Hangings: Analysis of Respiratory and Movement Responses to Asphyxia by Hanging*

ABSTRACT: The human pathophysiology of asphyxia by hanging is still poorly understood, despite great advances in forensic science. In that context, filmed hangings may hold the key to answer questions regarding the sequence of events leading to death in human asphyxia. Four filmed hangings were analyzed. Rapid loss of consciousness was observed between 13 sec and 18 sec after onset of hanging, closely followed by convulsions (at 14–19 sec). A complex pattern of decerebration rigidity (19–21 sec in most cases), followed by a quick phase of decortication rigidity (1 min 00 sec–1 min 08 sec in most cases), an extended phase of decortication rigidity (1 min 04 sec–1 min 32 sec) and loss of muscle tone (1 min 38 sec–2 min 47 sec) was revealed. Very deep respiratory attempts started between 20 and 22 sec, the last respiratory attempt being detected between 2 min 00 sec and 2 min 04 sec. Despite differences in the types of hanging, this unique study reveals similarities that are further discussed.

KEYWORDS: forensic science, hanging, asphyxia, video recording

The human pathophysiology of asphyxia by hanging is still poorly understood, despite great advances in forensic science (1). Even though some studies have been conducted on animals, the extent to which those results can be applied to human beings is highly questionable (1). However, experimental protocols on humans are out of the question, for obvious ethical concerns. Of course, execution judicial hangings were witnessed, but those deaths are very different in nature from typical hangings, death being caused by fracture-dislocation of the upper cervical vertebrae with transection of the cord rather than asphyxia by compression of neck structures. Therefore, it was proposed that filmed hangings may hold the key to a better understanding of human asphyxia (1).

When we presented our first video at the 58th Annual Meeting of the American Academy of Forensic Sciences, this video had been in our laboratory for several years before a systematic analysis was undertaken (1). Occasionally, we heard that other recordings of such hangings existed, mostly in the context of autoerotic accidents. In order to systematically review and compare those video recordings, the creation of a Working Group on Human Asphyxia was proposed. Each scientist who has such a video or who has access to such a video is welcome to join this group and the video will be added to our study.

We present the results of respiratory and movement responses analysis on four filmed hangings (two suicides and two autoerotic accidents).

Materials and Methods

A total of four filmed hangings were analyzed. In the first recording, presented in a previous paper (1), a man recorded his suicide with a video camera. He tied his neck with a padded rope fixed on the rail system on an electric garage door and used the remote control to close the door, therefore hanging himself. His feet were fixed in ski boots, tied with chains to a metal platform. In the second recording, a man masked with woman's underwear hanged himself in his garage, using a traditional hangman's noose made out of thick rope. A large white sheet was spread on the back wall. He hanged himself from a standing position, his knees slightly bent and his feet touching the floor. In the third recording, a man dressed in a cowboy costume hanged himself in a basement trap by letting go of the nearby ladder (free hanging). The last recording was of a suicide in custody, filmed by a surveillance camera. The victim was kneeling on the ground, the hanging ligature tied to the cell bars adjacent to the decedent.

For each video, we evaluated the time frame of body responses: loss of consciousness, convulsions, decortication and decerebration rigidity, loss of muscle tone, last muscle movement, and respiratory responses.

Results

With time 0 representing the onset of hanging, rapid loss of consciousness was observed (at 13–18 sec; Fig. 1). Loss of consciousness was largely assessed by a close examination of the victim's face in association with body tonus. In two cases (cases 2 and 4), loss of consciousness was not possible to evaluate. In case 2, this assessment was impossible because, as previously said, the victim's face was masked with underwear. In case 4, image quality from the surveillance camera was not optimal enough to estimate this issue adequately.

Convulsions then closely followed loss of consciousness in all cases (at 14–19 sec in all cases; Fig. 1). In the near seconds (19–21 sec in most cases and 46 sec in one case), decerebration rigidity was observed (Fig. 2), with full extension of both upper and lower limbs. Two phases of decortication rigidity were also noted, the first one being relatively sudden and quick (onset at around 1 min 00 sec–1 min 08 sec in most cases, 21 sec in one case) while the second one (onset between 1 min 04 sec–1 min 32 sec) extended

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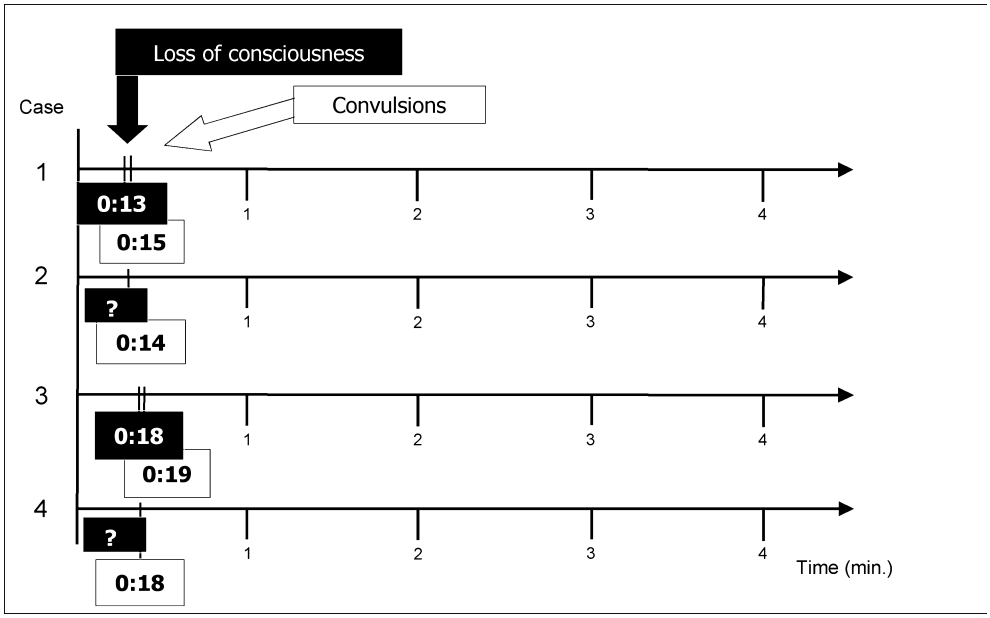

FIG. 1—*Time frame for loss of consciousness and onset of convulsions in each video recording.*

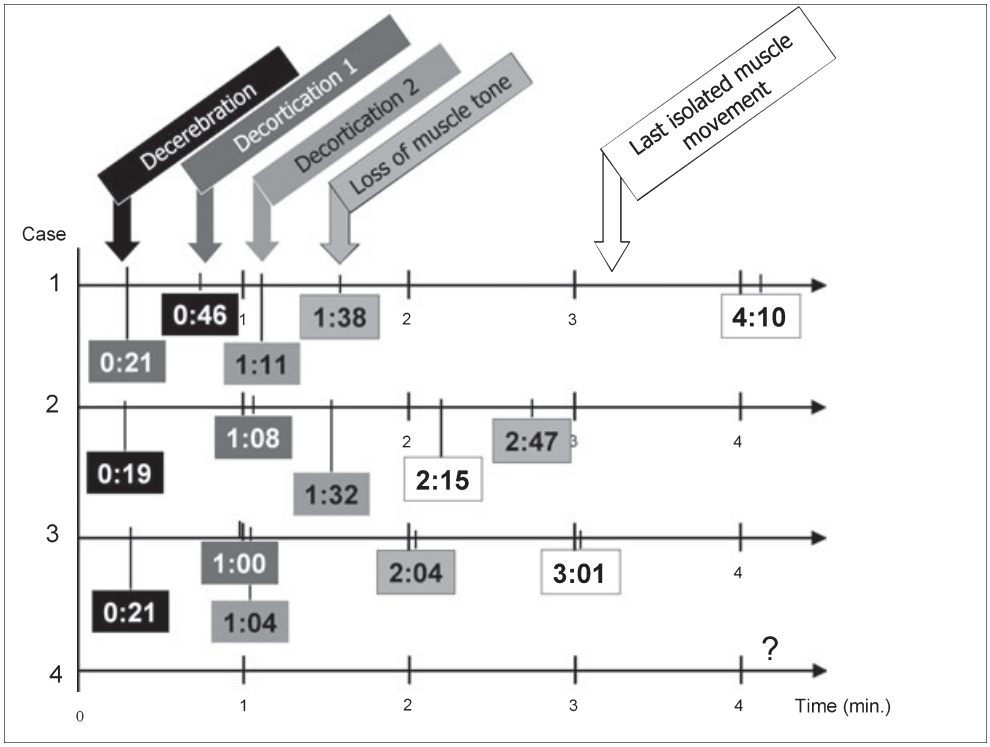

FIG. 2—*Time frame for body responses in each video recording.*

for about 1 min, with an observed climax of rigidity about 20 sec after its onset. Decortication rigidity is characterized by flexion of the upper limbs combined with extension of lower limbs and trunk. Appearance of loss of muscle tone varied between 1 min 38 sec and 2 min 47 sec, with last isolated muscle movement occurring between 2 min 15 sec and 4 min 10 sec. Once again, in case 4, suboptimal image quality limited the estimation of body responses (apart from convulsions, we were not able to accurately assess the time of occurrence of other movement responses).

As for the respiratory responses, the following sequence was observed: onset of very deep respiratory attempts between 20 sec and 22 sec, last attempt between 2 min 00 sec and 2 min 04 sec, for a total interval of 1 min 40 sec to 1 min 42 sec (Fig. 3).

Discussion

Forensic textbooks (2,3) state that asphyxia by hanging causes unconsciousness in an average of 10 sec. This commonly used time

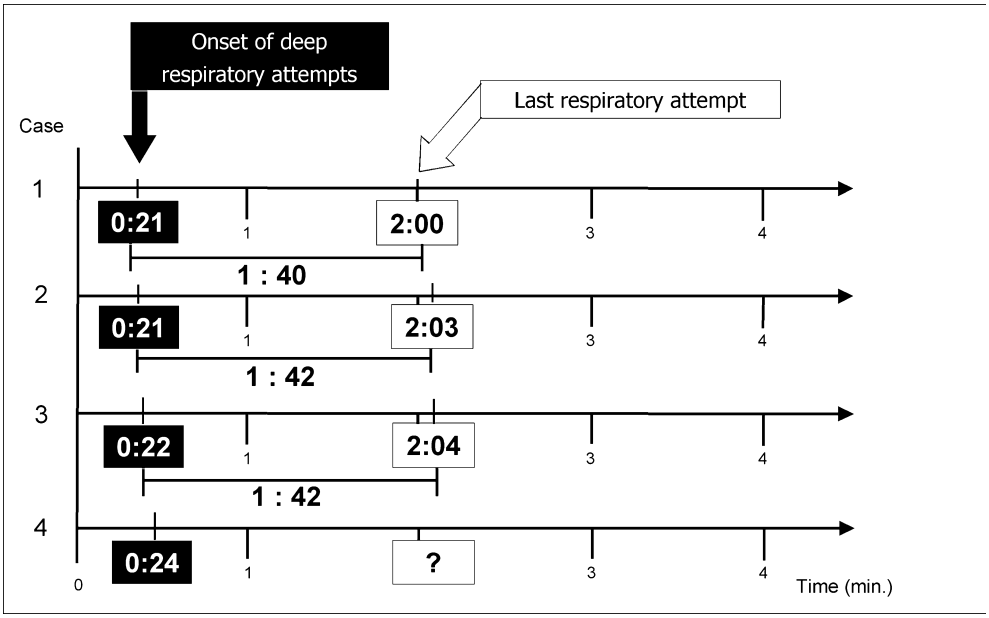

FIG. 3—*Time frame for respiratory responses in each video recording.*

frame, however, is based on very few objective data. The DiMaio's textbook (2) is referring to an instructive but strange old study by Rossen et al. (4), absolutely impossible to currently consider: 85 male volunteers from 17 to 31 years of age were asphyxiated by inflating a pressure cuff on their neck. Loss of consciousness was observed in 5–11 sec. Also worth mentioning is a German paper about an autoerotic accident by hanging recorded with a video camera (5): loss of consciousness occurred at about 55 sec. Our results are in accordance with this rapid loss of consciousness following asphyxia by hanging. As a matter of fact, in our study, loss of consciousness was noted between 13 and 18 sec.

Rapid loss of consciousness was closely followed by convulsions (at 14–19 sec). This correlates with convulsions following loss of consciousness in two other previously mentioned papers as well: the study by Rossen et al. (4) and the German filmed hanging (5).

As far as we know, the following sequences of body and respiratory movements are not clearly described in the literature. In the present study, we reported a complex pattern of decerebration rigidity (19–21 sec in most cases, 46 sec in one case), a quick phase of decortication rigidity (1 min 00 sec–1 min 08 sec in most cases–21 sec in one case), an extended phase of decortication rigidity (1 min 04 sec–1 min 32 sec) and loss of muscle tone (1 min 38 sec–2 min 47 sec). Decerebration rigidity indicates lesions at mid-brain level, whereas decortication rigidity points toward a cerebral cortex impairment. There is no clear explanation at this time why decerebration rigidity (mid-brain level impairment) preceded decortication ridigity (cerebral cortex impairment) in two cases out of three. Further research is necessary to achieve a better understanding of this phenomenon.

Subsequent to the complex pattern of decerebration–decortication rigidity and loss of muscle tone, isolated muscle movements were detected from time to time, the last one occurring between 2 min 15 sec and 4 min 10 sec. In the German filmed hanging (5), intermittent convulsions persisted for up to 6 min.

Onset of very deep respiratory attempts started between 20 sec and 22 sec, the last respiratory attempt being detected between 2 min 00 sec and 2 min 04 sec.

Conclusion

Despite differences in the types of hanging, similarities could be revealed regarding rapid loss of consciousness and onset of convulsions, pattern of decerebration and decortication rigidity, as well as respiratory responses. To date, this is a unique study of agonal movements in asphyxia by hanging.

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