

Article type:

Case report

Title:

*Fatal accidental asphyxia in the reverse jack-knife position
on a chair with wheels*

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Highlights

1. A female was found dead in the reverse jack-knife position.
2. No fatal trauma or lesions were found.
3. The effects of tofisopam and the deceased's poor physical condition had restricted her motility.
4. The cause of death in this case was considered to be positional asphyxia.
5. We should be aware that chairs with wheels can cause such accidents.

Graphical abstract

Fatal accidental asphyxia in a reverse jack-knife position



A female was found dead in a reverse jack-knife position.
The cause of death was considered as positional asphyxia.

Abstract

Accidental death from postural or positional asphyxia can occur when an individual's body compromises their respiration. The diagnosis of positional asphyxia is usually based on circumstantial evidence supported by the absence of other significant underlying causes of death. A female in her twenties was found dead in the so-called bridge position on a chair with wheels. Her jacket had rolled under one of the chair's wheels. She was 159 cm in height and weighed 28.8 kg. Her body mass index was 11.4 (she was severely emaciated), and her muscles, including the rectus abdominis muscle, were thin. Her head, face, and neck were markedly congested. Her lungs, especially the upper lobes, were also congested. A small quantity of left cardiac blood was detected, which was slightly coagulated. The right cardiac blood was liquid (21 ml), and the right ventricle was slightly enlarged. It was suggested that the circulation from the lungs to the heart had been restricted. Toxicological tests detected psychoactive agents in the deceased's blood and urine. The concentration of one of them, tofisopam, was slightly higher than normal. It was suggested that the effects of tofisopam and the deceased's poor physical condition had impaired her motility, trapping her in an abnormal body position, 'the reverse jack-knife position'. Therefore, her manner of death was considered to be accidental positional asphyxia. We should be aware that chairs with wheels can occasionally cause such accidents.

(233/within 250 words)

Keywords

positional asphyxia, accidental asphyxia, reverse jack-knife position,
manner of death, forensic autopsy

1. Introduction

Death from positional or postural asphyxia can occur when an individual's posture interferes with adequate breathing by causing partial or complete airway obstruction. Being in an inverted or head-down position for an extended period of time suppresses normal respiration and circulation, as mechanical and gravitational forces exert pressure on the diaphragm due to the weight of the viscera [1]. Positional asphyxia has been reported to occur in a variety of circumstances, such as during reverse suspension [2, 3] or in individuals in a hyperflexed head or head-down position [4, 5] or in the jack-knife position [6]. In addition, normal venous return to the heart is impaired in such cases, causing brain hypoxia due to marked congestion in the brain [7, 8]. It is not necessary for the whole body to be inverted for death to occur from positional asphyxia, as partial inversion of the torso and hyperflexion of the neck or being in a face-down position during inebriation can also be fatal [5].

The deleterious effects of these positions interfere not only with breathing, but also with blood flow in the brain and heart. The effects of such positions have been discussed in detail in the forensic literature, but only in relation to accidents (including motor vehicle accidents) involving pre-existing illnesses or the ingestion of alcohol or narcotic drugs [3-6, 9-13].

Bell, Swann, and Padosch [5, 14, 15] proposed the following criteria for diagnosing death due to accidental positional asphyxia: 1) It must

be determined that the deceased's body position would have obstructed normal gas exchange, 2) it must be determined that it would have been impossible for the deceased to change their body position, and 3) other causes of natural or violent death must be excluded.

We report an autopsy case, in which a female was found dead in a head-down and reverse jack-knife position. In this case, we diagnosed positional asphyxia based on the abovementioned criteria.

2. Case report

A female in her twenties, who was living alone, was found dead in the so-called 'bridge' posture. Her thighs and lumbar region were on the seat of a chair with wheels. The parietal region and both feet were touching the floor, and blood had leaked from the deceased's mouth. Her jacket had rolled under one of the wheels of the chair (Fig. 1). The seat of the chair was 38 cm in width, 40 cm in depth, and 50 cm from the floor. The deceased's home was in an orderly state, and diet foods, beer, and supplements were the only edible substances found in it.

The deceased had spoken with her family on her mobile phone 25 hours before she was found. Her family realized that she was in poor physical condition at that time.

Postmortem inspection findings: At postmortem, marked lividity was seen from the head to the thorax and on the upper limbs, lower thighs, and feet. It partially disappeared when pressure was applied. No postmortem rigidity was observed. The rectal temperature was 28°C, which was the same

as the room temperature. Based on these findings, it was considered that the deceased had been dead about 24 hours.

A forensic autopsy was performed three days after she was found. **Clinical history:** She had been clinically diagnosed with bulimia nervosa about one year ago, and she had been prescribed etizolam (Depas), tofisopam (Grandaxin), and alprazolam (Solanax).

2.1. Main autopsy findings

The deceased was 159 cm in height and weighed 28.8 kg. Her body mass index was 11.4; i.e., she was severely emaciated (Fig. 1).

Marked postmortem lividity was seen from the head to the thorax and on the upper limbs, lower thighs, and feet. The deceased's face was markedly congested (Fig. 2a), and petechiae and ecchymosis were observed on her facial skin, bulbar and palpebral conjunctivae (Fig. 2b), and labial mucosa (Fig. 2c). Her mouth contained a blood-like fluid.

No fatal trauma or lesions were found on her body.

The adipose tissue layer was 0.4 cm thick in the umbilical region. The deceased's muscles were generally thin, and the rectus abdominis muscle was also thin. Hemorrhage was seen in the temporalis muscle under the subcutaneous layer of the skin and the periosteum. No skull fractures were detected. The blood vessels in the brain were markedly congested. The deceased's heart weighed 168 g. There was a small quantity of left cardiac blood, which was slightly coagulated. The right cardiac blood was liquid (21 ml), and the right ventricle was slightly enlarged. The

lungs, especially the upper lobes, were also congested (Fig. 3a). Many small hemorrhages were observed in the tongue. No subcutaneous or muscular bleeding was seen in the neck. There was no rupturing or tearing of the esophagus. Each of the deceased's organs was smaller and lighter than normal (Table 1) [16].

2.2. Pathological examination

Heart: The myocardial fibers had thinned, and gaps were observed between them.

Lungs: Each section was congested, but not edematous (Fig. 3b).

Other organs: There were no pathological changes, except for congestion.

2.3. Toxicological examination

Ethanol analysis

Ethanol analysis was performed by headspace gas chromatography with flame ionization detection (HS-GC-FID) on a QP-2010 Plus GC (Shimadzu, Kyoto, Japan) [17]. The deceased's blood and urine alcohol concentrations were undetectable (less than 0.01 mg/ml).

Toxicological analyses

The toxicological analyses of blood and urine were performed by gas chromatography mass spectrometry (GC-MS) on a QP-2010 Ultra (Shimadzu, Kyoto, Japan), and a Prominence liquid chromatography system (Shimadzu UFLC system, Kyoto, Japan) coupled to a TSQ Quantum Access MAX tandem mass spectrometer (LC-MS/MS) (Thermo Scientific, Waltham, MA, USA) [18].

The therapeutic agents the deceased was taking; i.e., tofisopam, etizolam, and alprazolam, were detected in her cardiac blood and urine.

The results of the quantitative analyses of the levels of these drugs are summarized in Table 2.

2.4. Quantitative analyses of ketone bodies

The concentration of acetone was analyzed by headspace gas chromatography with flame ionization detection (GC-2010 Plus, Shimadzu, Kyoto, Japan), and that of 3-hydroxybutyric acid (3HBA) was analyzed by GC-MS/MS (GCMS-TQ8030, Shimadzu, Kyoto, Japan) [19].

The concentration of 3HBA was 240 $\mu\text{mol/l}$, and that of acetone was 16.9 $\mu\text{g/ml}$.

3. Discussion

Positional asphyxia has been reported in a variety of circumstances, such as during reverse suspension [3, 12] or in individuals in a hyperflexed head or head-down position [4, 5] or in the jack-knife position [6]. In the current case, the deceased was discovered in a strange posture, which we termed 'the reverse jack-knife position'. Except for the unusual position reported by Falk, there have been few autopsy reports about cases in which the deceased was found in a similar position [7].

In our case, we considered whether a diagnosis of positional asphyxia was applicable. To diagnose accidental asphyxia, the following

criteria are useful [5, 14, 15]: 1) It must be determined that the deceased's body position would have obstructed normal gas exchange, 2) it must be determined that it would have been impossible for the deceased to change their body position, and 3) other causes of natural or violent death must be excluded.

Did the deceased's body position obstruct normal gas exchange in the present case? She was found in a face-up position. Her hips were on a chair, and her head and feet were on the floor. Thus, it was considered that the movement of her diaphragm would have been restricted. A small quantity of left cardiac blood was found, which had slightly coagulated. The right cardiac blood was liquid (21 ml), and the right ventricle was slightly enlarged. In addition, the deceased's lungs were congested. These findings suggested that the circulation from the lungs to the heart had been restricted. Thus, the deceased's body position might have obstructed normal gas exchange.

Was it impossible for the deceased to change her body position? Acute alcohol intoxication is a major risk factor for positional asphyxiation. Drug abuse is also a risk factor for positional asphyxiation [5, 20]. Central nervous system depression causes relaxation of the muscles that keep the airway open during sleep, particularly the genioglossal muscle, which draws the tongue forward during inspiration and prevents it from entering the pharynx [21, 22]. Bell et al. [5] reported that degenerative brain disease, such as dementia, is the second most important risk factor for positional asphyxiation after excess alcohol

consumption.

In our case, the deceased had been clinically diagnosed with bulimia nervosa. She was being treated with tofisopam, etizolam, and alprazolam, which were detected in her cardiac blood and urine. Of these drugs, the blood concentrations of etizolam and alprazolam were below therapeutic levels; i.e., <5.0 ng/ml. The blood concentration of tofisopam was 287 ng/ml. Following the intake of 100 mg of tofisopam, the maximum plasma concentration ranges from 40.9 ng/ml to 655.6 ng/ml [23]. The deceased's blood concentration fell within this range. Tofisopam is usually taken at a dose of 50 mg three times a day. Therefore, it is possible that the deceased took a higher than normal dose of tofisopam, such as 100 mg, which could have induced drowsiness, wooziness, and/or vertigo. This might explain why she collapsed and remained in an abnormal position. Alcohol was not detected in the deceased's blood or urine. Thus, it is considered that alcohol did not affect her ability to move.

In addition, she had not been diagnosed with diabetes mellitus, and it was considered that her ketone body level was not indicative of ketosis or ketoacidosis [19, 24].

The deceased's jacket had rolled under one of the wheels of her chair and the upper part of her body was upside down. It appears that an accident had occurred, causing the deceased to fall backwards. Physically, her body mass index was 11.4; i.e., she exhibited severe emaciation and hyposthenia, and her rectus abdominis muscle was thin. Thus, she could not escape from the restrictive position she found herself

in, resulted in positional asphyxia.

4. Conclusion

A young female was found dead in a strange position (the reverse jack-knife position) in a chair. The congestion seen in the brain and lungs, and the analysis of the deceased's cardiac blood suggested that the circulation from the lungs to the heart had been inhibited. Thus, the deceased's body position might have obstructed normal gas exchange. Furthermore, the effects of tofisopam and the deceased's poor physical condition might have restricted her motility. Therefore, the manner of death in this case was considered to be positional asphyxia.

We should be aware that chairs with wheels can occasionally cause such accidents.

5. Conflicts of interest

We declare no conflicts of interest associated with this case report.

6. References

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7. Figure and table legends

- Fig. 1 The deceased's body position
 a: upper view, b: right-sided view
- Fig. 2 Physical findings

 Petechiae and ecchymosis were observed on the facial skin

 (a), bulbar and palpebral conjunctivae (b), and labial

 mucosa (c).
- Fig. 3 Congestion of the lung

 A macroscopic overview of the right lung is shown (a).

 Microscopic congestion was seen, but edema was not (left

 upper lobe, b).
- Table 1 The weights of the deceased's organs in comparison with their

 standard weights

 *: mean weight for females of the same age [16]

 L: left, R: right
- Table 2 Concentrations of the detected drugs

Fig. 1

The deceased's body position



a: upper view, b: right-sided view

Fig. 2 Physical findings

Petechiae and ecchymosis were observed on the facial skin (a), bulbar and palpebral conjunctivae (b), and labial mucosa (c).

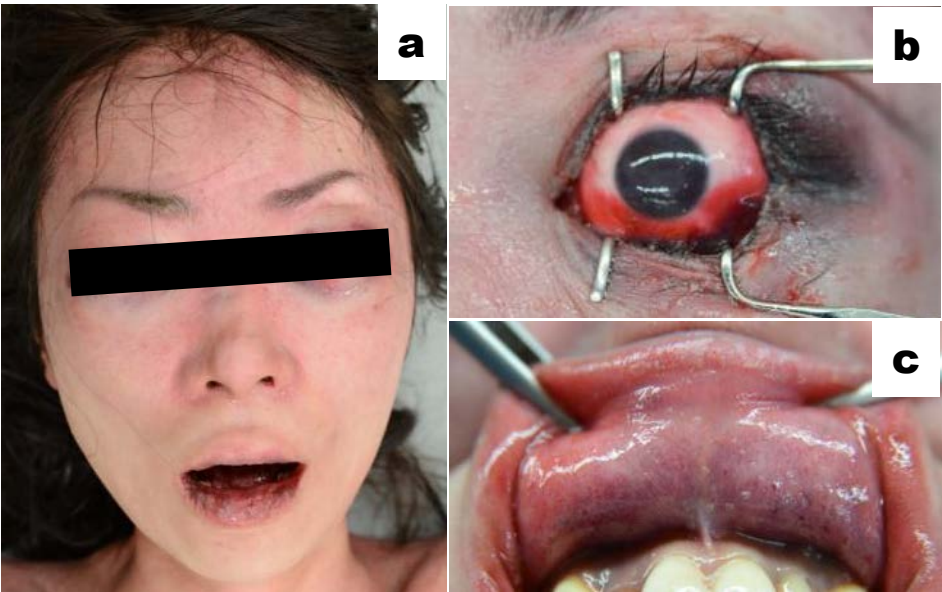


Fig. 3

Congestion of the lung

A macroscopic overview of the right lung is shown (a).

Microscopic congestion was seen, but edema was not (left upper lobe, b).

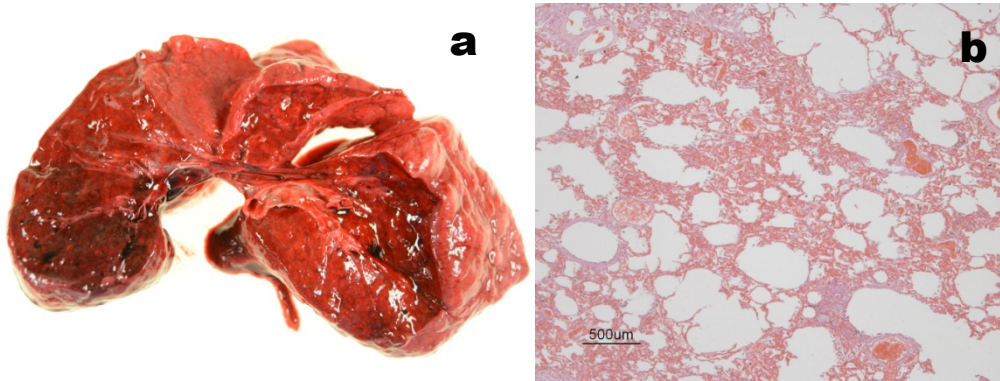


Table 1

The weights of the deceased's organs in comparison with their standard weights

	This case	Standard weight*
Height (cm)	159	158.63±5.82
Weight (kg)	28.8	49.36±11.66
Brain (g)	1367	1314.28±108.07
Heart (g)	168	241.54±57.92
Lungs (g)		
L	306	381.95±125.85
R	287	430.39±153.26
Liver (g)	635	1276.93±297.17
Spleen (g)	29	96.80±39.81
Pancreas (g)	36	81.71±18.36
Kidneys (g)		
L	80.8	121.38±24.64
R	88.2	110.99±22.64

*: mean weight for females of the same age [16]

L: left, R: right

Table 2 Concentrations of the detected drugs

Drugs	Concentration (ng/ml)	
	Blood	Urine
Tofisopam (an anxiolytic benzodiazepine)	287	419
Etizolam (a short-acting psychoactive drug)	<5.0	9.5
Alprazolam (a short-acting anxiolytic)	<5.0	<5.0