

Fatalities related to medical restraint devices—Asphyxia is a common finding

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Abstract

A total of seven detailed death investigations is reported where death occurred while being restrained by a belt or a protective cover. The casualties were elderly persons who mostly showed considerable pre-existing diseases, especially dementia and coronary atherosclerosis. Concerning the cause of death, three groups were differentiated: (I) mechanical asphyxia from strangulation. (II) Mechanical asphyxia from thoracic/abdominal compression. (III) Compression of thorax/abdomen without clear signs of asphyxia. Subgroups II and III each involved one case of rib fractures without preceding resuscitation. In subgroup III, the presence of considerable compression of the trunk and the absence of a natural cause of death strongly indicate a causal connection between compression and death, e.g. from a shortened course of fatal asphyxia, endocrine stress reactions or a head-down-position: cardiac arrest in a helpless situation. The method of restraint was inadequate in most cases in that only one device was used which did not restrict the capability to move sufficiently. A good clinical documentation including medical indication, duration and method of restraint and a description/photograph of the original on-site appearance is essential but was not present in most cases. Therefore, prophylaxis is based on a clear medical indication, the proper use of restraint devices, detailed instructions of the nursing personnel and close monitoring. The forensic investigation should aim at a complete reconstruction based on autopsy, histology, toxicology and inspection of the scene and the medical records.

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1. Introduction

The demographic and medical development in industrialised nations will produce a dramatic increase in the absolute and relative numbers of elderly persons in need for nursing care. As a consequence, cases of abuse and neglect of the elderly [1,3,11,12,18,25] are likely to increase in the future. Complications in elderly persons restrained by a medical device constitute a special subgroup. Studies on the prevalence of restraint-related injuries have revealed only low rates of minor complications [26,29]. On the other hand, there are several reports of elderly fatalities where death occurred in a helpless situation while restrained by a medical device [3,4,5,15,22–24,28]. A total of seven such cases is reported to demonstrate that these cases do not represent literary rarities

and that a detailed death investigation can demonstrate findings indicative of local mechanical compression and/or asphyxia in just about all cases.

2. Material and methods

The cases originated from the autopsy files of the Institute of Legal Medicine, University of Münster, Germany, from 1997 to 2004. In all of these cases, the following investigations were performed:

- Full forensic autopsy including dissection of the posterior soft tissues and the extremities (peeling-off procedure) and dissection of the neck in a bloodless field.
- Extensive histology of all relevant organs and immunohistochemical examination of the heart for early hypoxic lesions of the myocardium [17].
- Toxicology: general unknown analysis using GC/MS after solid phase extraction of body fluids.
- Inspection of the scene including reconstruction of the original on-site appearance.
- Inspection of the medical records.

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3. Case reports

3.1. Case 1

83-year-old woman, severe dementia, restraint in a geriatric home by a nursing bedcover fixed to both sides of the bed at three locations (shoulders, pelvis, ankles), found dead in the morning by a nurse.

Scene findings: buttocks and legs touching the ground to the right-hand side of the bed, the upper opening of the nursing bedcover wrapped tightly around the neck (Fig. 1). No resuscitation.

External examination: Almost circular and 3-mm wide strangulation mark with skin abrasions around the neck (Fig. 2) descending to the left axilla. Intense congestion and cyanosis syndrome above the neck ligature including numerous petechiae in the skin of the face and conjunctivae and congestion bleeding from the external auditory meatus (Figs. 1 and 2).

Autopsy: Numerous petechiae and ecchymoses in the scalp, Mm. temporales and pharyngeal mucosa. Haemorrhages in the laryngeal muscles and floor of the mouth. Subpleural and epicardial petechiae. Suggillation in the muscles of the back. Myocardial hypertrophy, internal and external hydrocephalus.

Histology: Acute lung emphysema, isolated ecchymoses in the lung parenchyma, generalized atherosclerosis, myocardial fibrosis and cerebral cortical atrophy.



Fig. 1. Case 1: original on-site-appearance of the body.

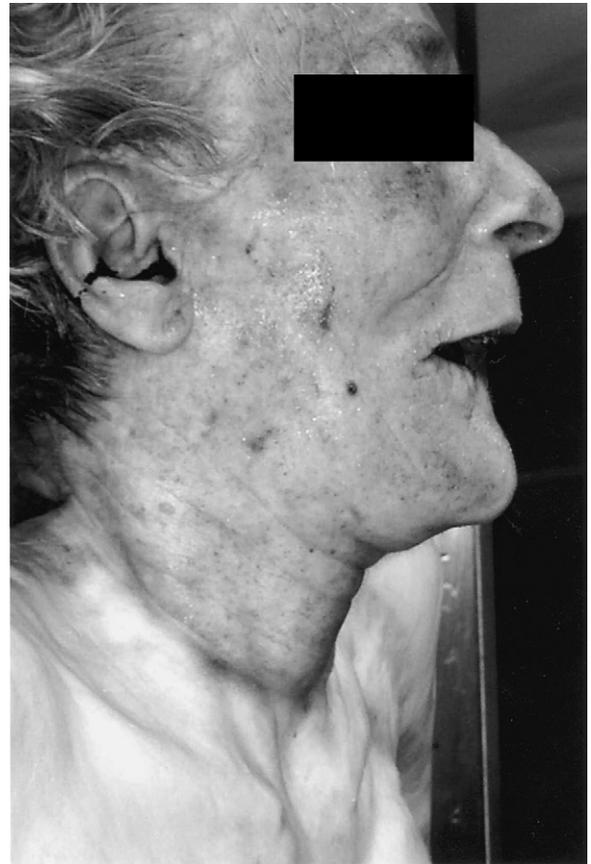


Fig. 2. Case 1: intense congestion syndrome of the head above the ligature mark. Note the congestion bleeding from the external auditory meatus.

Cause of death: Self-strangulation.

Reconstruction: The middle knot of the bedcover at the height of the pelvis had loosened so that the lower part of the body was able to slide out of the bed, thus applying tension to the neck which was still fixed by the upper knot. The left arm included in the neck ligature probably was the result of a self-rescue attempt.

3.2. Case 2

60-year-old woman, psychosis and epilepsy, geriatric nursing home, medical restraint approved by a physician, found dead in the early morning by a nurse.

Scene findings: Hanging in a squatting position in the waist belt displaced to the thorax, feet touching the ground next to the bed, left elbow positioned on the bedrails which were down (Fig. 3). No resuscitation.

External examination: Almost circular belt imprint at the back and anterior chest in the form of a 6-cm wide band-like pallor with narrow reddish margins (Fig. 4). Flattening of the left chest. Skin abrasions left anterior chest, haematoma left flank. Numerous skin petechiae below the belt pressure mark and on the legs. Isolated conjunctival petechiae.

Autopsy: Soft tissue haematoma measuring 6 cm × 4 cm in the left flank. Serial rib fractures (4–10) in the anterior fold of the axilla on the left-hand side including dislocation and



Fig. 3. Case 2: sketch of the original on-site-appearance of the body.

haemorrhage. Acute pulmonary emphysema. Petechiae underneath the pleura and in the pelvis of the kidneys.

Histology: Acute lung emphysema, atherosclerosis, myocardial fibrosis and cloudy swelling of hepatocytes.

Cause of death: Asphyxia from thorax compression.

Reconstruction: Enough space to move for displacement of the body out of bed and of the belt to the thorax. The body weight supplied the tension to the belt with resulting compression of the thorax. Since no resuscitation had occurred, the serial rib fractures clearly were the result of vital trauma.



Fig. 4. Case 2: intense band-like belt imprint mark. The pallor surrounded by reddish margins exactly reflects the form of the belt. The left chest is flattened from serial rib fractures without preceding resuscitation.

3.3. Case 3

72-year-old man, agitated dementia, restraint in a geriatric home approved by a physician, found dead in the evening by an auxiliary nurse.

Scene findings: Sitting on the ground in front of the bed, back leaning slightly against the bed, a waist belt displaced diagonally to the thorax (Fig. 5). No bedrails. Unsuccessful resuscitation.

External examination: Several belt impressions at the left-hand side of the anterior and posterior thorax from the pelvis to the axilla with pallor and surrounding streaky skin reddening and petechiae. Isolated petechiae in the conjunctivae and in the skin of the eyelids.

Autopsy: Intense soft tissue haemorrhages in the back and chest at the left side below the skin belt marks including a large decollement. Numerous subpleural petechiae. Generalized atherosclerosis, myocardial hypertrophy and old infarction, hydrocephalus internus.

Histology: Severe pre-existing myocardial fibrosis and old infarction, acute and chronic lung emphysema, haemorrhagic lung edema and cerebral cortical atrophy.

Cause of death: Asphyxia from thorax compression.

Reconstruction: Enough space to move for displacement of body and belt. Compression mainly to the left-hand side of the thorax with intense belt impressions and soft tissue haemorrhage.

3.4. Case 4

91-year-old woman, surgical department (femur fracture), post-operative restlessness with falls, waist belt Segufix[®], found with cardiac standstill by her grand-daughter, death 20 min later after initially successful resuscitation.

Scene findings: Hanging in the waist belt displaced to both axillae, the feet touching the ground close to the bed, the buttocks above the ground and both arms raised above the head

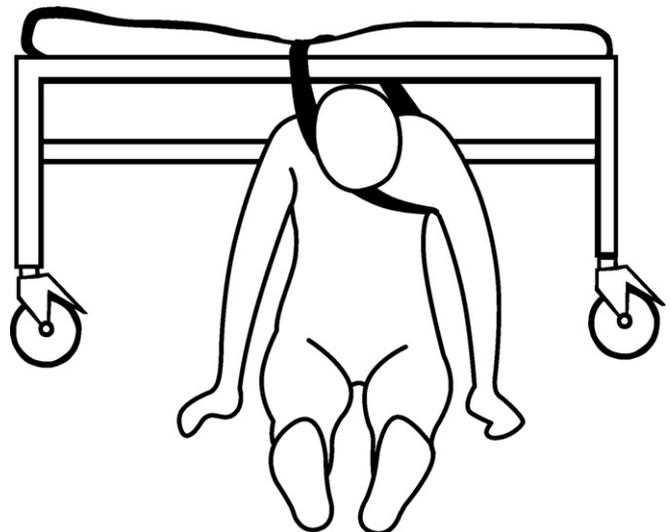


Fig. 5. Case 3: sketch of the original on-site-appearance of the body.

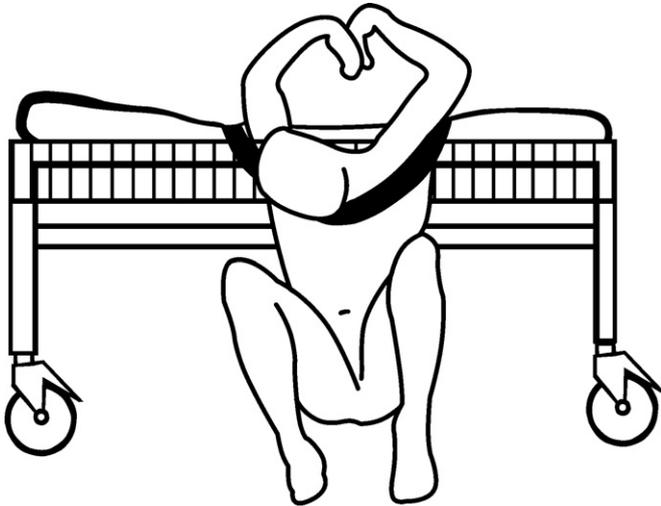


Fig. 6. Case 4: sketch of the original on-site-appearance of the body.

(Fig. 6). Skin of face and arms was noted as bluish discoloration. Bedrails turned down.

External examination: Streaky diagonal skin abrasions of the left chest. Numerous conjunctival petechiae and few petechiae in the skin of the eyelids.

Autopsy: Numerous ecchymotic haemorrhages in the Mm. intercostales and in the muscles of the chest and back. Bilateral serial rib fractures with slight haemorrhage on the right and intense haemorrhage on the left-hand side. Subpleural petechiae, acute pulmonary emphysema. Generalized atherosclerosis, tracheobronchitis and purulent vesical cystitis.

Histology: Advanced coronary sclerosis, myocardial hypertrophy and patchy interstitial fibrosis.

Cause of death: Asphyxia from thorax compression.

Reconstruction: Enough space for displacement of body and belt with resulting thorax compression. This may have caused the rib fractures on the left-hand side, which showed only slight haemorrhage contrary to those on the right-hand side.

3.5. Case 5

90-year-old woman, agitated dementia, restraint in a geriatric nursing home approved by court, found dead at night by the night nurse.

Scene findings: In a prone position hanging half out of bed with the pelvis on the bedrails (up-position), the legs out of bed and the upper body inside the bed. The waist belt displaced below the left axilla and around the right upper arm (Fig. 7). The head and abundant vomit inside the pillow.

External examination: Bandlike pallor and streaky reddenings in the skin of the abdomen (Fig. 8), fresh haematoma at the outside of the right upper arm.

Autopsy: Advanced generalized atherosclerosis, myocardial hypertrophy and old infarction, chronic liver congestion, leg edema, cerebral atrophy and aspiration of stomach content.

Histology: Pronounced coronary sclerosis, several myocardial micro-scars and old infarction, acute and chronic lung emphysema.

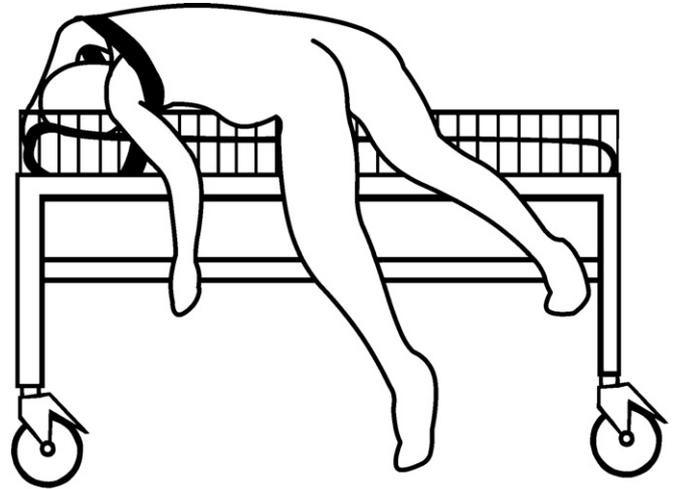


Fig. 7. Case 5: sketch of the original on-site-appearance of the body.

Cause of death: Cardiac arrest in a helpless situation.

Reconstruction: Enough space for removal of the right arm and displacement/rotation of the body. Considerable compression in a prone and head-down-position (streaky reddenings and haematoma) combined with aspiration of stomach content probably produced or enhanced stress reactions which at least contributed to cardiac arrest.



Fig. 8. Case 5: bandlike pressure mark from the waist belt. The location in the abdominal skin probably reflects the original position of the belt which was later found below the left axilla and around the right upper arm.

3.6. Case 6

80-year-old woman, dementia, restraint with Segufix[®] waist belt in her own home approved by a physician, found lifeless by an auxiliary nurse, unsuccessful resuscitation.

Scene findings: Waist belt in place; head, arms, upper trunk and legs hanging out of the side of the bed (Fig. 9). Bedrails in a down-position.

External examination: Isolated petechiae in the skin of the left eyelid and the back of both feet.

Autopsy: Fresh ecchymoses of the pancreas and no clear signs of asphyxia. Generalized atherosclerosis and chronic pulmonary emphysema.

Histology: Severe coronary sclerosis including small vessels, intense myocardial fibrosis and chronic congestion of the liver.

Cause of death: Cardiac arrest in a helpless situation.

Reconstruction: Enough space to move for displacement of the body but not the belt. Considerable compression (pancreatic haemorrhage) and the head-down-position most likely initiated stress reactions which at least contributed to cardiac arrest.

3.7. Case 7

88-year-old woman, dementia, geriatric nursing home, medical restraint with Segufix[®] waist belt and bedrails at night, found dead in the early morning by nurses.

Scene findings: Hanging in the waist belt displaced diagonally to the thorax, the feet touching the ground next to the bed, the buttocks slightly above the ground, the head leaning against the mattress (Fig. 10). Bedrails in a down-position. No resuscitation.

External examination: Pressure mark in the skin of both flanks and the pelvis on the right-hand side with pallor and abrasions (direction from bottom-to-top). Fresh haematomas at the right knee.

Autopsy: Ecchymotic haemorrhages below the pressure mark also including the back muscles, lateral fracture of the 10th rib on the right-hand side with suggillation. Generalized atherosclerosis, myocardial hypertrophy and fibrosis, osteoporosis and cerebral atrophy.

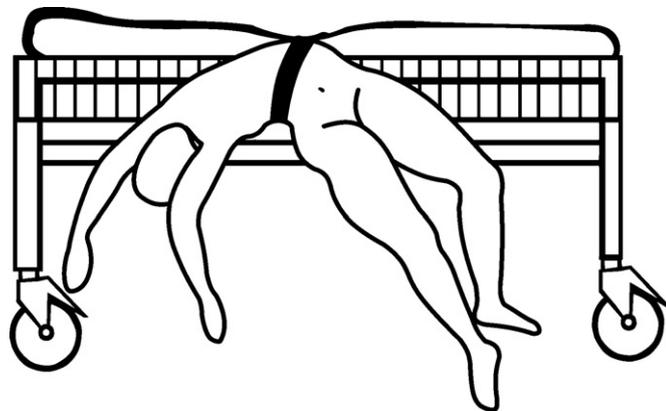


Fig. 9. Case 6: sketch of the original on-site-appearance of the body.

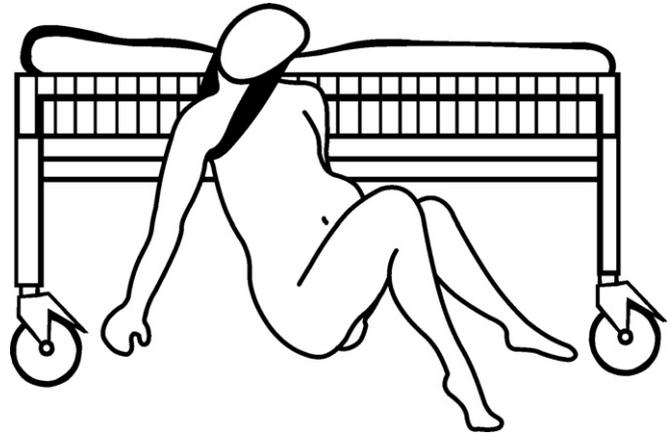


Fig. 10. Case 7: sketch of the original on-site-appearance of the body.

Histology: Pronounced coronary sclerosis, many myocardial micro-scars and fibrosis, chronic emphysema and congestion of the lungs and Alzheimer's disease.

Cause of death: Cardiac arrest in a helpless situation.

Reconstruction: Again, there was enough room for displacement of the body and belt. Asphyxial findings were absent but the rib fracture without preceding resuscitation indicates considerable abdominal compression. Together with mild positional asphyxia, compression-induced stress reactions probably caused or contributed to cardiac arrest.

In none of the cases did toxicological analysis yield a result which may have contributed to the events.

4. Discussion

If a corpse is found tangled up in a medical restraint device death may be due to this device or natural disease. On the basis of detailed post-mortem examinations, three groups can be differentiated with regard to the location and the effect of the compressive force:

- (1) Mechanical asphyxia from strangulation (case 1) where the tension is generated by both the ligature and the body weight. A bandlike strangulation mark of the neck, petechiae underneath serous membranes, petechial bleedings in the conjunctivae and a congestion syndrome of the head including additional petechiae were present in our case.
- (2) Mechanical asphyxia from thoracic or abdominal compression (cases 2–4) which prevents respiratory movements or even crushes the thorax. Regular findings included a bandlike compression mark and corresponding haemorrhages in the soft tissues, petechiae underneath serous membranes and in the head, especially in the conjunctivae, and acute lung emphysema. Rib fractures were present in two fatalities (cases 2 and 4), one of them without preceding resuscitation. This demonstrates that considerable force can be applied to the thoracic wall from fighting or hanging in a displaced restraint belt even if concomittant diseases such as osteoporosis can favour the occurrence of fractures.

(3) Thoracic or abdominal compression without clear signs of asphyxia (cases 5–7). A bandlike compression mark and/or corresponding haemorrhages in the soft tissues including ecchymoses in the pancreas were found in all and a rib fracture without preceding resuscitation in one case. However, this considerable mechanical compression did not produce distinctive findings of mechanical asphyxia. It may therefore be speculated that these patients got tangled up in the restraint device during agony from a natural cause of death. However, even detailed post-mortem examinations were not able to demonstrate such a natural cause of death. In addition, it appears highly unrealistic to assume that weakened and moribund patients dying from a natural disease will show a stormy agony including a high level of motor activity [22]. We therefore conclude that mechanical compression was also causal for or at least contributed substantially to death. There are several possible mechanisms:

- Compression-induced stress reactions such as catecholamine release, hyperthermia and rise of the blood lactate can produce sudden asystolic cardiac arrest [2,6,10,14,16,21].
- Fatal asphyxia can take a shortened and mild course in the mostly moribund patients which all showed intense coronary sclerosis and myocardial scars/fibrosis in histological examination so that signs of asphyxia may not develop.
- The head-down-position in cases 5 and 6 also favoured cardiac and circulatory arrest.

Quite a number of group I cases (strangulation and asphyxia) including compression from bedrails and bars have been published [3–5,13,15,19,20,22–24,27,28] but there are only few reports of group II (asphyxia from thoracic or abdominal compression) [15,22]. This has led some authors [9,22] to the assumption that compression-induced stress-reactions, which are quite difficult to verify post-mortem, instead of asphyxia, are the major cause of death. In our experience, however, asphyxial findings can be demonstrated in many cases of trunk compression by a detailed post-mortem investigation. In those cases where asphyxial findings are absent (group III), the presence of considerable compressive effects in the skin, soft tissues or organs is decisive: a causal connection between compression and death can be established if a natural cause of death cannot be demonstrated and the reconstruction at the scene is consistent with this hypothesis. We call this concept “cardiac arrest in a helpless situation”, i.e. a mild course of asphyxia and compression-induced stress reactions. A detailed investigation including autopsy, histology, toxicology, examination of the medical records and inspection of the scene is therefore necessary in all restraint-related fatalities, especially in category III where a natural cause of death has to be ruled out.

Inspection of the scene is important because the bed and restraint devices can be investigated and the original and final positions of the body can be re-enacted, thus gaining important information for the reconstruction of the events. Inspection of

the scene is also necessary to evaluate if the restraint devices applied to the patient were adequate. A protective cover (case 1) should never be (mis)utilized for restraint [15,22] and a waist belt requires the simultaneous use of bedrails and of the lateral fixations of the belt, which was not done in cases 2–4, 6 and 7. Such inadequate restraint techniques, which have been recorded in similar cases before [3,8,15,22,23], do not prevent a displacement of the patient’s body. Consequently, prophylaxis is based on the proper use of restraint devices, on detailed instructions of the nursing personnel and also on close monitoring, especially in the presence of dementia or apractic disorders.

A clear medical documentation of the restraint device concerning indication, duration and method of restraint was lacking in most cases and the documentation of the accident including the original on-site appearance was mostly incomplete. Ironically, this may be one reason why no consequences under criminal law were drawn. A substantial number of unreported cases is likely for the same reason [3,7,15,22,23]. The problem lies in the fact that it is easy to change the scene or conceal evidence. The expert examining the scene should therefore compare the scene reconstruction to the autopsy findings and check for plausibility.

In conclusion, all restraint-related fatalities should be considered unclear deaths where autopsy and additional investigations including histology, toxicology, inspection of the scene and examination of the medical records are mandatory. The differential diagnosis of fatal asphyxia versus death from natural pre-existing disease can be difficult if thoracic or abdominal compression is obvious but vital signs of asphyxia are missing (category III, cardiac arrest in a helpless situation). In these cases, a shortened course of fatal asphyxia and additional factors such as pathophysiological stress reactions or a head-down-position have to be considered carefully against the possibility of a death from natural disease ending up in such an extraordinary position.

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