



## Review

## Neck vascular lesions in hanging cases: A literature review

Mahmut Asirdizer<sup>a,\*</sup>, Erhan Kartal<sup>b</sup><sup>a</sup> Forensic Medicine. Head of the Department of Forensic Medicine, Medical Faculty of Bahçeşehir University, Istanbul, Turkey<sup>b</sup> Forensic Medicine. Head of the Department of Forensic Medicine, Medical Faculty of Van Yuzuncu Yil University, Van, Turkey

## ARTICLE INFO

## Keywords:

Amussat's sign  
 Etienne Martin's sign  
 Dominguez-Paez sign  
 Friedberg-Lesser sign  
 Ziemke-Otto's sign  
 Lupascu sign

## ABSTRACT

The aim of this review was to investigate the types and rates of vascular lesions occurring in cases of completed hanging and near-hanging, defined in literature.

In the literature to date, 6 specific types of vascular injuries have been defined in cases of death as a result of hanging. These are Amussat's sign, Etienne Martin's sign, Dominguez-Paez sign, Friedberg-Lesser sign, Ziemke-Otto's sign, and Lupascu sign.

As a result of this study, it was determined that the most defined finding was the Amussat sign, and it was concluded that the other findings were not sufficiently recognized.

Likewise, considering that the proportional differences are due to the differences in the rates of autopsy practice and autopsy protocols between countries, it can be suggested that international joint autopsy protocols should be developed at the meetings in which national professional associations participate.

## 1. Introduction

Suicide, which is among the top 10 causes of death worldwide, occurs in different forms in different countries depending on cultural, economic, and social conditions.<sup>1</sup> In Bahrain, Japan, Thailand, most European countries, and Turkey, hanging is the primary method of suicide.<sup>1</sup> Accidental hangings are infrequent and represent approximately 2%–6.5% of all hanging cases.<sup>2–5</sup> Cases of homicidal hangings are extremely rare and represent 1.6% of all hanging cases.<sup>6,7</sup> In a study on the death penalty, which has been abolished or is not applied in many countries today, it was seen that 36 methods have been defined throughout history, the foremost of which was reported to be hanging.<sup>8</sup>

In the autopsies of hanging deaths, some mild or severe lesions may be seen in the soft tissues and muscles, veins and bones of the neck, which are not dependent on the manner of death, but are associated with some factors such as the type of hanging, the weight of the victim, and the duration of hanging.<sup>9</sup> Ligature knot and hanging mark are visible signs of hanging on external examination.<sup>9–14</sup> On internal examination, lesions that can be seen include a silver line (=argent line =),<sup>9,10</sup> hemorrhagic infiltration in the soft tissues under the ligature mark,<sup>9–11,13,14</sup> hemorrhage in the neck muscles,<sup>9–15</sup> fractures of the hyoid bone and/or laryngeal cartilages, especially in the horns of the thyroid cartilage,<sup>9–11,13,14</sup> fractures in the upper cervical vertebrae, especially in the 2nd (Hangman's fracture) and 3rd cervical

vertebra,<sup>9–11,16</sup> ruptures of the ligaments and the disc between the 6th and 7th cervical vertebrae and hemorrhages (Simon's sign),<sup>14,15</sup> medulla spinalis injuries,<sup>9</sup> vascular lesions,<sup>9,10,12–16</sup> and very occasionally, decapitation.<sup>17–19</sup>

The aim of this review was to investigate the types and rates of vascular lesions occurring in cases of completed hanging and near-hanging which have been defined in literature.

## 2. Vascular injuries

In the literature to date, 6 specific types of vascular injuries have been defined in cases of death as a result of hanging. The most common of these is Amussat's sign,<sup>14</sup> which is seen as transverse tears of the carotid artery intima (Fig. 1/A).<sup>9,12–14,20</sup> The second of these six findings is Etienne Martin's sign, which is seen as a hematoma in the adventitia of the carotid artery and is more rarely defined (Fig. 1/B).<sup>14,21–23</sup> The third is the Dominguez-Paez sign, which presents as hemorrhage without a tear under the intima of the carotid artery and is also very rarely defined (Fig. 1/C).<sup>21,22,24</sup> The fourth is the Friedberg-Lesser sign, which is seen as tears in the internal or external carotid artery intima and is also very rarely defined.<sup>21</sup> The fifth is Ziemke-Otto's sign, which is seen as transverse tears in the jugular vein intima, not in the carotid artery<sup>14,21–23,25,26</sup> (Fig. 1/D). The sixth is the Lupascu sign, which is microscopic splintering in the pericarotid bone.<sup>9–11,13,14</sup>

\* Corresponding author. Head of Department of Forensic Medicine, Medical Faculty of Bahcesehir University, Istanbul, Turkey.

E-mail addresses: [mahmut.asirdizer@med.bau.edu.tr](mailto:mahmut.asirdizer@med.bau.edu.tr) (M. Asirdizer), [dr.erhankartal@yyu.edu.tr](mailto:dr.erhankartal@yyu.edu.tr) (E. Kartal).

2.1. Amussat's sign

Described in 1828 by the French surgeon Jean Zulema Amussat (1796–1856), the Amussat sign generally consists of transverse rupture of the intimal layer of the primitive (internal) carotid artery.<sup>24</sup> However, the ruptures of the intimal layer of carotid arteries occur more often in individuals of older age due to the advancement of degenerative atherosclerotic changes.<sup>9,12</sup>

Sometimes the Amussat sign is accompanied by longitudinal tears and hemorrhagic infiltrates in the carotid adventitia, and sometimes intima tears merge with tears in the media and adventitia layer.<sup>9,12,20</sup> This damage to the carotid artery can cause occlusion of the artery through wall thrombosis, large subintimal hematoma or intramural bleeding, and therefore cerebral ischemia in survivors of hanging.<sup>9,27–32</sup>

The Amussat's sign can be caused by direct compression of the

hanging material or by the indirect stretching of the body weight with the effect of gravity.<sup>9,12,14</sup> It has been suggested that a combination of forced compression and longitudinal stretching of the artery may be the most important mechanism leading to rupture of the intimal layer of suspended carotid arteries.<sup>12,14</sup> The Amussat sign, which is accepted as evidence of premortem hanging,<sup>14</sup> is not unique to hanging, but can also occur due to blunt neck trauma, excessive extension or flexion of the neck, and whiplash injuries.<sup>9,12</sup>

It has been suggested that the occurrence of the Amussat sign in hanging cases is independent of gender, weight, the completeness of the suspension of the victim's body and the location of the ligament knot on the neck.<sup>10,12</sup>

According to Paez, in 1947 Balthazard stated that he saw the Amussat sign in 80% of the cases executed by hanging, while in 1955, 8 years later, Simonin reported the rate of the Amussat sign as only 4%.<sup>24</sup>

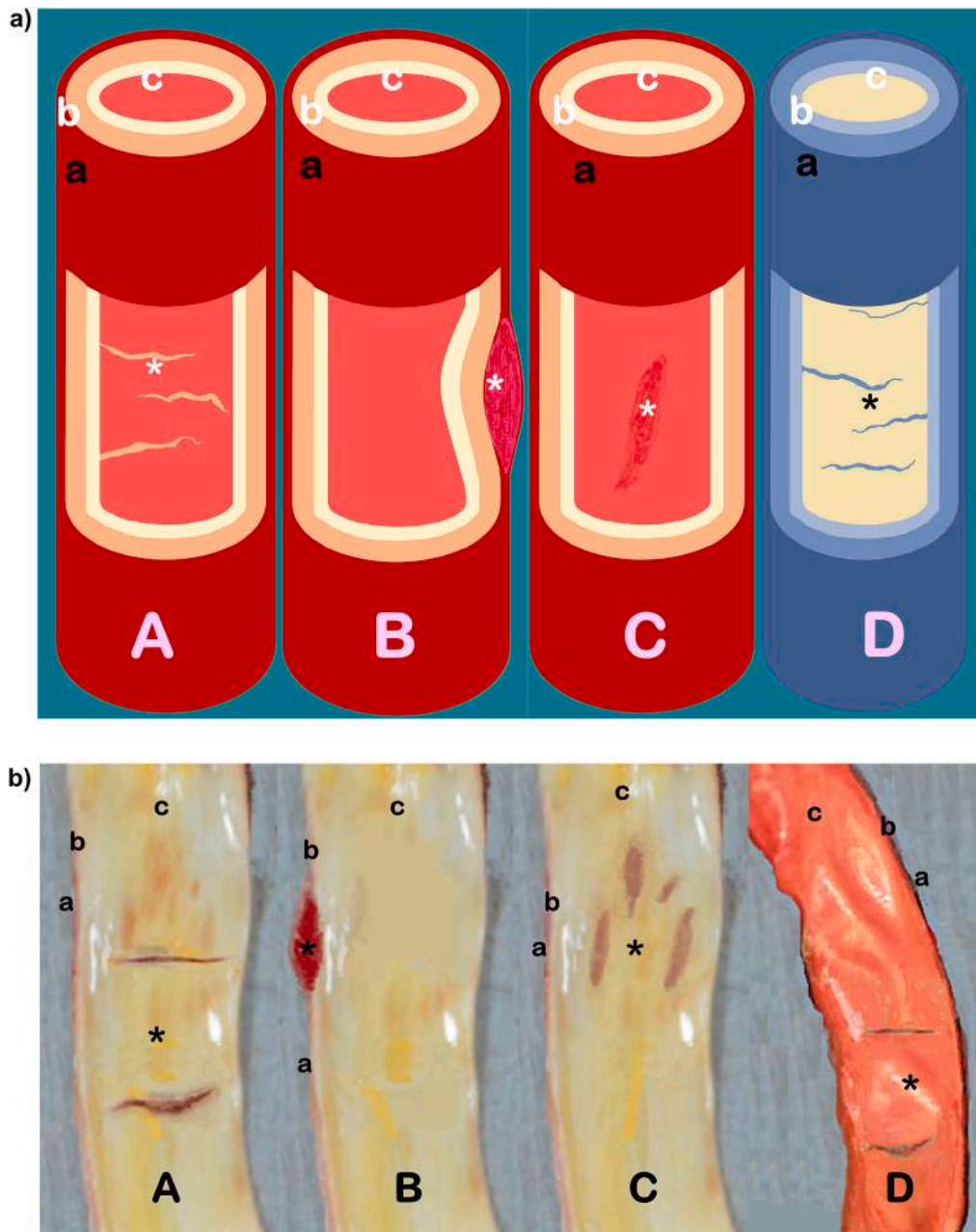


Fig. 1. a) Graphical View, b) Pictorial View [(a): Adventitia, (b) Media (=Muscularis = ), (c): Intima]. A) Amussat's sign (\*): transverse tears of the carotid artery intima. B) Etienne Martin's sign (\*): a hematoma in the adventitia of the carotid artery. C) Dominguez-Paez sign (\*): the hemorrhage without a tear under the intima of the carotid artery. D) Ziemke-Otto's sign (\*): transverse tears in the jugular vein intima.

In a study by Dagli of 166 cases of suicidal hanging, it was stated that the presence or absence of the Amussat sign was mentioned in only 22 cases, and the Amussat sign was found to be positive in 2 (9.1%) of these 22 cases.<sup>9</sup>

In a study by Hejna, 29 (16.1%) cases with the Amussat sign were identified among 178 suicidal hanging cases.<sup>12</sup> Hejna observed the Amussat sign in 12.5% of cases where the node was in the posterior, in 28.6% of cases where the node was on the right, in 19.4% of cases where the node was on the left, and it was not observed in any case where the node was in the anterior.

Laiho examined 124 cases of suicidal hanging and stated that the Amussat sign was present in 16%.<sup>33</sup>

Hejna reported that the incidence of Amussat sign among autopsy cases was determined as 7.4% in 204 cases by Schroeder and Satenus, 14% in 50 cases by Lesser, and 25% in 12 cases by Jankovich.<sup>12</sup>

Kurtulus detected the Amussat sign in 4 (3.9%) of 102 suicidal hanging deaths. Kurtulus recorded the Amussat sign in 75% of cases where the node was in the anterior, and in 25% of cases where the node was on the side.<sup>13</sup>

Huacolianes observed the Amussat sign in 11 (25.58%) of 43 hanging cases and this rate reached 60.47% in microscopic examination.<sup>14</sup> Of these cases, 63.6% were related to incomplete hangings and a statistical relationship was determined between the Amussat sign and proximal node position.

Rao described transverse tears in the intima of the internal carotid artery in 138 (52.27%) of 264 cases of suicidal hanging, which were evaluated as consistent with the Amussat sign.<sup>34</sup>

Russo et al. identified the Amussat sign in 34 (17%) of 260 completed cases of suicidal hanging.<sup>35</sup>

Rodríguez et al. reported that the Amussat sign was present in 38 (97.44%) of 39 cases of death due to hanging.<sup>21</sup>

Ruiz identified the Amussat sign in 25% of 48 victims who died by hanging.<sup>22</sup>

In addition to the above autopsy case series, the Amussat sign has been described in case reports macroscopically,<sup>15,33,36–40</sup> microscopically,<sup>23,25</sup> and radiologically.<sup>41</sup>

## 2.2. Etienne Martin's sign

The Etienne Martin sign, which is considered most likely a sign of vitality, consists of a hemorrhagic infiltration in the adventitial wall of the carotid as a result of rupture of the vasa vasorum.<sup>14</sup>

Huacolianes observed Etienne Martin's sign macroscopically in 23 (53.49%) of 43 hanging cases, and this rate reached 60.47% in microscopic examination.<sup>14</sup> The rates of Amussat sign were determined as 25.58% in complete hangings and as 27.91% in incomplete hangings.

Ruiz identified the Etienne Martin's sign in 3 (6.1%) of 48 victims who died by hanging.<sup>22</sup>

Rodríguez et al. reported that Etienne Martin's sign was present in 39 (100%) of 39 cases of hanging-related death, and also named this finding the "Friedberg-Pellacani sign".<sup>21</sup>

In contrast, Etienne Martin (1950) defined this as a finding that shows hanging and named it "La facies sympathique" (the sympathetic face).<sup>42,43</sup> He stated that if the corpse's eyes are closed or partially open, there is dilatation or moderate dilation of the pupils, and the pupil is dilated so that the eye remains open on the pressured side of the ligament, death may be considered to be the result of hanging.

## 2.3. Dominguez-Paez sign

This finding was reported as axial hemorrhage beneath the intimal surface of the common carotid artery without intimal tear.<sup>22,24</sup> It was defined in 19 (48.72%) of 39 hanging cases by Rodríguez et al.<sup>21</sup>

## 2.4. Friedberg-Lesser sign

This finding was defined by Rodriguez et al. in 17 (43.59%) of 39 hanging-related deaths,<sup>21</sup> and no other literature could be found on this subject.

## 2.5. Ziemke-Otto's sign

Huacolianes did not observe Ziemke-Otto's sign macroscopically, but it was observed microscopically in 7 (16.28%) of 43 hanging cases.<sup>14</sup> This author stated that 57.14% of Ziemke-Otto's signs were in incomplete hangings and 71.43% were in completed hangings, which was not considered to be a definitive indication of antemortem hanging.

Rodríguez et al. reported that Ziemke-Otto's sign was present in 15 (38.46%) of 39 cases of hanging-related death.<sup>21</sup>

## 2.6. Lupascu sign

This finding was defined by Rodriguez et al. in 11 (28.21%) of 39 hanging-related deaths,<sup>21</sup> and no other literature could be found on this subject.

## 2.7. Unclassified vascular injuries

Suarez-Penaranda et al. reported intimal injuries in the carotid artery (9.1%), intimal injuries in the jugular vein (2.2%), and ruptures of the carotid adventitial layer (21.7%) in 228 hanging cases (2 were due to accidents, the others were due to suicides).<sup>10</sup>

In 175 cases of suicidal hanging, Nolic et al. reported 32 vessel injuries (transverse intimal tears and perivascular hematomas) in 27 (15.4%), and these vascular injuries were not classified.<sup>20</sup>

Sharma et al. reported injury to the neck vessels in 6 (9.1%) of 66 hanging cases and 2 (25%) of 8 ligature strangulation cases.<sup>44</sup>

Das et al. defined carotid artery injuries in 51 (24%) of 210 hanging deaths, and stated that 34 of these injuries were in the adventitia, 16 in the intima, and 1 in all layers.<sup>45</sup>

Jayaprakash and Sreekumari determined carotid intimal tear in 1.1% of 189 cases of death due to hanging.<sup>46</sup>

The incidence of carotid artery injuries among near-hanging cases has been reported to be 1%–3%.<sup>47–49</sup>

Unclassified carotid artery injuries have been described in some case reports of hanging or near-hanging.<sup>50–52</sup>

Vertebral artery injuries and supra-aortic artery injuries have been reported as other unclassified vascular injuries.<sup>9,14,21,53,54</sup>

## 2.8. Cases without vascular injury

In a retrospective analysis of the autopsy reports of 761 cases of hanging, Uzün et al. reported that intimal damage was not detected in the carotid arteries in any of the cases.<sup>55</sup>

In some studies where the autopsy reports of hanging cases were retrospectively analyzed, the authors have reported that vascular injuries were not detected in any of the cases in their series.<sup>55,56</sup>

## 3. Discussion

In this article, the types and frequencies of vascular injuries in the neck region were reviewed, mostly in cases of death after hanging, and in some near-hanging cases.

The Amussat sign was the most frequently mentioned vascular injury, although it was not fully named in some literature. The rate ranged from 3.9% to 97.44%. The reason for this difference was thought to be due to factors that needed to be investigated, such as the time devoted to the examination of the vascular structures during autopsy procedures, whether microscopic examination was performed, whether the correct samples were taken, and the tendency of the vascular

structures to atherosclerosis due to regional dietary habits.

The incidence of Etienne Martin's sign ranged from 6.1% to 100%.<sup>14,21,22</sup> The reason for the difference between these rates was thought to be the same as for the Amussat sign. Olano et al. suggested that vascular injuries such as Etienne Martin's sign can also be identified using techniques such as Nuclear Magnetic Resonance Imaging as an addition to autopsy or in cases where autopsy is not required.<sup>23</sup> In addition, angiography and CT angiography techniques were used in some studies for evaluation of vascular injuries in near-hanging or hanging cases.<sup>29,30,49,57</sup>

The definition of Dominguez-Paez sign was found in only three articles written in Spanish,<sup>21,22,24</sup> and the rate defined in one of these was 48.72%.<sup>21</sup>

The definition of Friedberg-Lesser sign was found in only one article written in Spanish, with an incidence of 43.59%.<sup>21</sup>

Ziemke-Otto's sign has been mentioned in 6 studies, but the frequency was only stated in two as 16.28% and 38.46%.<sup>14,21</sup> The lower rate of occurrence of lesions in the jugular vein than in the carotid artery can be explained by the higher content of elastic fibers in the jugular vein. These dense elastic fibers make the vessel more flexible and more resistant to rupture.<sup>10</sup>

The Lupascu sign was only reported by Rodriguez et al. in 28.21% of hanging-related deaths.<sup>21</sup>

The results of this study revealed that vascular findings, with specific names other than the Amussat Sign, are not well known in the forensic medicine community in cases of hanging-related deaths, and it was also understood that vascular injuries were not mentioned in many studies, and there were no vascular injury records in retrospective studies. In addition, it is obvious that in many hanging cases, radiological and microscopic examinations that will enable better definition of vascular injuries are not performed. It is even known that in some countries, some law enforcement officers avoid autopsy in hanging cases, considering crime scene investigation and external examination of the corpse to be sufficient.

It can be suggested that the creation of common autopsy protocols to be followed in different cases would prevent such shortcomings and these could be established with the collaboration of national forensic medicine societies.

## Declaration of competing interest

There is not any financial or ethical conflict.

## References

- Bidaki R, Shirani S, Shamsian M, et al. A review of the various suicide methods used around the world. *Int J Med Rev*. 2016;3(4):504–507. <https://doi.org/10.15171/ijmr.2016.11>.
- Dhiab MB, Jdidi M, Nouma Y, Mansour NB, Belhadj M, Souguir MK. Accidental hanging: a report of four cases and review of the literature. *J Clin Pathol Forensic Med*. March 2014;5(1):1–5. <https://doi.org/10.5897/JCPFM2013.0043>.
- Nouma Y, Ben Ammar W, Bardaa S, Hammami Z, Maatoug S. Accidental hanging among children and adults: a report of two cases and review of the literature. *Egypt J Food Sci*. 2016;6:310–314. <https://doi.org/10.1016/j.ejfs.2015.07.001>.
- Dogan KH, Demirci S, Erkol Z, Gulmen MK. Accidental hanging deaths in children in Konya, Turkey between 1998 and 2007. *J Forensic Sci*. 2010;55(3):637–641. <https://doi.org/10.1111/j.1556-4029.2010.01320.x>.
- Gok E, Cetin S, Baduroglu E, Fedakar R, Akan O, Saka NE. Two accidental hanging cases of children. *J Pakistan Med Assoc*. 2015;65(7):790–792.
- Sharma L, Khanagwal VP, Paliwal PK. Homicidal hanging. *Leg Med*. 2011;13(5):259–261. <https://doi.org/10.1016/j.legalmed.2011.05.009>.
- Sauvageau A. True and simulated homicidal hangings: a six-year retrospective study. *Med Sci Law*. 2009;49(4):283–290. <https://doi.org/10.1258/rsmmsl.49.4.283>.
- Usmonovna OG, Kholmurodovich OB. In the history of the ancient world, the death penalty. *Novateur Publications*. 2020;6(8):100–106.
- Dagli S. Denizli'de 2013 - 2019 Yılları Arasındaki Asiya Bağlı Ölümlerin Retrospektif Değerlendirilmesi [Retrospective Evaluation of hanging deaths between 2013-2019 in Denizli (Turkish)]. Department of Forensic Medicine, Medical Faculty of Pamukkale University, Specialization Thesis, Denizli – 2019.
- Suárez-Peñaranda JM, Alvarez T, Miguéns X, et al. Characterization of lesions in hanging deaths. *J Forensic Sci*. 2008;53(3):720–723. <https://doi.org/10.1111/j.1556-4029.2008.00700.x>.
- Amadasi A, Buschmann CT, Tsokos M. Complex fracture patterns in hanging associated with a fall from height. *Forensic Sci Med Pathol*. 2020;16(2):359–361. <https://doi.org/10.1007/s12024-019-00210-6>.
- Hejna P. Amussat's sign in hanging—A prospective autopsy study. *J Forensic Sci*. 2011;56(1):132–135. <https://doi.org/10.1111/j.1556-4029.2010.01548.x>.
- Kurtulus A, Yonguc GN, Boz B, Acar K. Anatomopathological findings in hangings: a retrospective autopsy study. *Med Sci Law*. 2013;53(2):80–84. <https://doi.org/10.1258/msl.2012.012030>.
- Huacolianes LEC. report Lesiones Vasculares en Ahorcados y su Relación Con el Tipo de Suspensión en Cadáveres Autopsiados en la Unidad Zonal de Medicina Legal Zona 9, Periodo Enero - Junio 2018 [Vascular Lesions in Hanged People and Their Relation to the Type of Suspension in Autopsied Corpses at the Forensic Medicine Zonal Unit Zone 9, Period January-June 2018 (Spanish)]. Faculty of Medical Sciences, Central University of Ecuador, Postgraduate Forensic Medicine Thesis. Quito- 2018.
- Doichinov ID, Doichinova YA, Spasov SS, Marinov ND. Suicide by unusual manner of hanging. A case report. *Folia Med (Plovdiv)*. 2008;50(1):60–62.
- Kaiser R, Saur K, Smolanka A, Ullas G, Beneš V. Type-III Hangman's fracture combined with serious cerebrovascular injury after near-hanging: a first case report and review of the literature. *Br J Neurosurg*. 2019;28:1–4. <https://doi.org/10.1080/02688697.2019.1671952>.
- Rothschild MA, Schneider V. Decapitation as a result of suicidal hanging. *Forensic Sci Int*. 1999;106(1):55–62. [https://doi.org/10.1016/s0379-0738\(99\)00140-1](https://doi.org/10.1016/s0379-0738(99)00140-1).
- Raja U, Sivaloganathan S. Decapitation—a rare complication in hanging. *Med Sci Law*. 1997;37(1):81–83. <https://doi.org/10.1177/002580249703700119>.
- Tracqui A, Fonmartin K, Géraud A, Pennera D, Doray S, Ludes B. Suicidal hanging resulting in complete decapitation: a case report. *Int J Leg Med*. 1998;112(1):55–57. <https://doi.org/10.1007/s004140050199>.
- Nikolic S, Micic J, Atanasijevic T, Djokic V, Djonic D. Analysis of neck injuries in hanging. *Am J Forensic Med Pathol*. 2003;24(2):179–182. <https://doi.org/10.1097/01.PAF.0681069550.31660.f5>.
- Rodríguez UPM, Rodríguez ARM. Muerte por ahorcadura en necropsias de ley [Death by hanging at necropsy law(Spanish)]. *Revista Médica Basadrina*. 2017;2:4–10.
- Ruiz PH. Valoración Médico Legal de Las Asfíxias. Estudio Especial de Las Ahorcaduras [Legal Medical Assessment of Asphyxia. Special Study of Hangings (Spanish)]. Department of Preventive Medicine and Public Health, Food Sciences, Toxicology and Forensic Medicine. Faculty of Medicine and Dentistry. Valencia: University of Valencia. Doctoral Thesis of Forensic Medicine and Public Health; 2015.
- Olano AS, Martínez-García P, Granero RJ P, Palanco JLR. Muerte por ahorcadura [Death by hanging (Spanish)]. *Cuad Med Forense*. 2005;11(40):145–149.
- Dominguez-Paez P. Dominguez-Páez signo [Dominguez-Paez sign (Spanish)]. *Medicina Legal*. 1986;5:4–5.
- Fernandez-Flores A, Orduña O, Carranza V. Study of morphological changes in the skin of the neck in suicidal cases by hanging. *Soud Lek*. 2011;56(2):24–26.
- Mollinedo EQ. Identificación de las Características y Métodos de Suicidio más Usados en la Ciudad de La Paz y El Alto, Gestión 2013 [Identification of methods of suicide and features in the city of peace and high management 2013 (Spanish)]. Universidad Mayor de San Andrés Faculty of Medicine, Nursing, Nutrition and Medical Technology Postgraduate Unit. Thesis. La Paz - Bolivia; 2015.
- Hausmann R, Betz P. Delayed death after attempted suicide by hanging. *Int J Leg Med*. 1997;110(3):164–166. <https://doi.org/10.1007/s004140050057>.
- Maier W, Fradis M, Malatskey S, Krebs A. Diagnostic and therapeutic management of bilateral carotid artery occlusion caused by near-suicidal hanging. *Ann Otol Rhinol Laryngol*. 1999;108(2):189–192. <https://doi.org/10.1177/000348949910800215>.
- Kiani SH, Simes DC. Delayed bilateral internal carotid artery thrombosis following accidental strangulation. *Br J Anaesth*. 2000;84(4):521–524. <https://doi.org/10.1093/oxfordjournals.bja.a013484>.
- Kadic L, Maandag NJ, Janssen CM, Driessen JJ, Kool LJ. An unexpected outcome of cervical near-hanging injury. A case report. *Acta Anaesthesiol Belg*. 2010;61(2):79–81.
- Hellier C, Connolly R. Cause of death in judicial hanging: a review and case study. *Med Sci Law*. 2009;49(1):18–26. <https://doi.org/10.1258/rsmmsl.49.1.18>.
- Kibayashi K, Shimada R, Nakao KI. Delayed death due to traumatic dissection of the common carotid artery after attempted suicide by hanging. *Med Sci Law*. 2019;59(1):17–19. <https://doi.org/10.1177/0025802418825390>.
- Laiho K, Isokoski M, Hirvonen J, Ojala K, Marttila A, Tenhu M. Über die obduktionsbefunde bei eelbstmord durch erhangen [About the autopsy findings for suicide by hanging]. *Deutsche Zeitschrift für gerichtliche Medizin*. 1968;63:63–69. <https://doi.org/10.1161/01.CIR.20.4.511>.
- Rao D. An autopsy study of death due to Suicidal Hanging – 264 cases. *Egypt J Food Sci*. 2016;6:248–254. <https://doi.org/10.1016/j.ejfs.2015.01.004>.
- Russo MC, Verzeletti A, Piras M, De Ferrari F. Hanging deaths: a retrospective study regarding 260 cases. *Am J Forensic Med Pathol*. 2016;37(3):141–145. <https://doi.org/10.1097/PAF.0000000000000239>.
- Cascini F, Longo F, Polacco M, Scafetta I. Foreign object ingestion in complex suicide: a case report and review of the literature. *Forensic Sci Int*. 2012;219(1-3):e1–e3. <https://doi.org/10.1016/j.forsciint.2011.11.015>.
- Dinis-Oliveira RJ, Carvalho F, Duarte JA, Dias R, Magalhães T, Santos A. Suicide by hanging under the influence of ketamine and ethanol. *Forensic Sci Int*. 2010;202(1-3):e23–e27. <https://doi.org/10.1016/j.forsciint.2010.04.047>.
- Klein A, Neumann L, Püschel K. Amussat- und andere typische Zeichen der Strangulation. Literaturreview zu den Merkmalen am Hals von Strangulationsopfern [Amussat's and other typical signs of strangulation. Review of the literature on neck lesions in victims of hanging (German)]. *Rechtsmedizin*. 2016;26:211–217. <https://doi.org/10.1007/s00194-015-0068-8>.

39. Kramer L, Große Perdekamp M, Geisenberger D, Pircher R, Pollak S, Schmidt U. Pseudo-tying injuries in a hanged person. *Forensic Sci Int*. 2016 Nov;268:e13–e17. <https://doi.org/10.1016/j.forsciint.2016.09.008>.
40. Mittal P, Sharma G. Pneumomediastinum and cervical soft tissue emphysema as an important vital sign in hanging: an autopsy based prospective study. *J Forensic Res*. 2017;8(2):371. <https://doi.org/10.4172/2157-7145.1000371>.
41. Aspalter M, Linni K, Domenig CM, Mader N, Klupp N, Hölzenbein TJ. Successful repair of bilateral common carotid artery dissections from hanging. *Ann Vasc Surg*. 2013;27(8):1186. <https://doi.org/10.1016/j.avsg.2013.03.008>. e7-e15.
42. Patel-Ankur P, Bhoot-Rajesh R, Patel-Dhaval J, Patel Khushbu A. Study of violent asphyxial death. *Int J Med Toxicol Forensic Med*. 2013;3(2):48–57.
43. Vijayakumari N. *A Study of Injuries to Neck Structures in Cases of Hanging*. Institute of Forensic Medicine, Madras Medical College. Dissertation of Doctor of Medicine in Forensic Medicine. 2010. Chennai.
44. Sharma BR, Harish D, Sharma A, Sharma S, Singh H. Injuries to neck structures in deaths due to constriction of neck, with a special reference to hanging. *J Forensic Leg Med*. 2008 Jul;15(5):298–305. <https://doi.org/10.1016/j.jflm.2007.12.002>.
45. Das TK, Pathak NM, Gogoi RK. Neck structure injuries in hanging cases brought for autopsy at A.M.C.H. Mortuary, Dibrugarh: two years retrospective study. *Paripex - Indian J Res*. 2018;7(1):37–38.
46. Jayaprakash S, Sreekumari K. Pattern of injuries to neck structures in hanging-an autopsy study. *Am J Forensic Med Pathol*. 2012;33(4):395–399. <https://doi.org/10.1097/PAF.0b013e3182662761>.
47. Boots RJ, Joyce C, Mullany DV, et al. Near-hanging as presenting to hospitals in Queensland: recommendations for practice. *Anaesth Intensive Care*. 2006;34(6):736–745. <https://doi.org/10.1177/0310057X0603400610>.
48. Salim A, Martin M, Sangthong B, Brown C, Rhee P, Demetriades D. Near-hanging injuries: a 10-year experience. *Injury*. 2006;37(5):435–439. <https://doi.org/10.1016/j.injury.2005.12.013>.
49. Nichols SD, McCarthy MC, Ekeh AP, Woods RJ, Walusimbi MS, Saxe JM. Outcome of cervical near-hanging injuries. *J Trauma*. 2009;66(1):174–178. <https://doi.org/10.1097/TA.0b013e31817f2c57>.
50. Advenier AS, de la Grandmaison GL. Traumatic rupture of deep neck structures in hanging: two case reports. *Am J Forensic Med Pathol*. 2014;35(3):189–192. <https://doi.org/10.1097/PAF.0000000000000114>.
51. Borowski DW, Mehrotra P, Tennant D, El Badawey MR, Cameron DS. Unusual presentation of blunt laryngeal injury with cricotracheal disruption by attempted hanging: a case report. *Am J Otolaryngol*. 2004 May-Jun;25(3):195–198. <https://doi.org/10.1016/j.amjoto.2003.11.001>.
52. Dedouit F, Tournel G, Bécart A, Hédouin V, Gosset D. Suicidal hanging resulting in complete decapitation—forensic, radiological, and anthropological studies: a case report. *J Forensic Sci*. 2007;52(5):1190–1193. <https://doi.org/10.1111/j.1556-4029.2007.00503.x>.
53. Reay DT, Cohen W, Ames S. Injuries produced by judicial hanging. A case report. *Am J Forensic Med Pathol*. 1994;15(3):183–186. <https://doi.org/10.1097/0000433-199409000-00001>.
54. Ribaute C, Darcourt J, Patsoura S, et al. Should CT angiography of the supra-aortic arteries be performed systematically following attempted suicide by hanging? *J Neuroradiol*. 2021;48(4):271–276. <https://doi.org/10.1016/j.neurad.2019.04.001>.
55. Uzun I, Buyuk Y, Gurpinar K. Suicidal hanging: fatalities in Istanbul retrospective analysis of 761 autopsy cases. *J Forensic Leg Med*. 2007;14(7):406–409. <https://doi.org/10.1016/j.jflm.2007.01.002>.
56. Elfawal MA, Awad OA. Deaths from hanging in the eastern province of Saudi Arabia. *Med Sci Law*. 1994;34(4):307–312. <https://doi.org/10.1177/002580249403400406>.
57. Linnau KF, Cohen WA. Radiologic evaluation of attempted suicide by hanging: cricotracheal separation and common carotid artery dissection. *AJR Am J Roentgenol*. 2002;178(1):214. <https://doi.org/10.2214/ajr.178.1.1780214>.