

## Unusual autopsy finding: Simon's bleeding

Neobičajen obdukcijski izvid: Simonova krvavitev

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### Abstract

**Objective:** To determine whether or not hanging had taken place before or after the death of the victim is quite important in the identification of criminal cases pretended to be suicidal attempts.

**Material and Methods:** Evidence for Simon's bleeding was searched in cases included in the study group after retracting soft tissue and organs away from the field of interest for full exposure of the region of lumbar spinal vertebrae without macroscopic grading of the severity of bleeding, and determining the lumbar level of bleeding. The cases autopsied in Bursa Morgue Department between 2009 and 2011 were retrospectively investigated and evaluated.

**Results:** A total of 848 cases (664 males, and 184 females, male/female ratio, 3.6 : 1) were included in the study. A total of 270 (31.8 %) cases had Simon's bleeding. A significant difference in the frequency of Simon's bleeding exists among various causes of death. A 28.5 % (n = 77) of the cases with Simon's bleeding were in the group with hanged death cases (p < 0.001).

**Conclusion:** Splinter bleedings identified originally by Simon on the ventral, and later dorsal aspects of the spinal discs in cases of hanging were also observed later in deaths not related to hanging, however it was concluded that these types of bleeding could not be detected in cases of postmortem hanging. When we evaluated all groups, the results we obtained do not support the assertion that the incidence of Simon's

bleeding decreases with aging. Instead, when compared with all other groups, the incidence of Simon's bleeding was also higher in cases of hanging with the highest mean age.

### Izvleček

**Cilj:** Pri odkrivanju kriminalnih primerov, ko gre za navidezni poskus samomora, je pomembno ugotoviti, ali je bila žrtev obešena pred smrtjo ali po njej.

**Material in metode:** Pri primerih, vključenih v študijsko skupino, smo iskali znake Simonove krvavitve po odstranitvi mehkih tkiv in organov iz opazovanega področja za popolno izpostavljenost vretenc v ledvenem predelu hrbtenice, brez makroskopskega ocenjevanja stopnje krvavitve, in določanje ravni krvavitve v ledvenem predelu. Retrospektivno so raziskovali in ocenjevali primere, ki so jih obducirali na Oddelku mrtvašnice v Bursi med letoma 2009 in 2011.

**Rezultati:** V raziskavo je bilo vključenih skupno 848 primerov (664 moških in 184 žensk; razmerje M/Ž 3,6 : 1). Simonova krvavitev je bila prisotna v skupno 270 (31,8 %) primerih. Med različnimi vzroki smrti so bile pomembne razlike v pogostosti Simonove krvavitve. 28,5 % (n = 77) primerov Simonove krvavitve je bilo ugotovljenih v skupini smrti zaradi obešenja (p < 0,001).

**Zaključek:** Trakaste krvavitve, ki jih je prvi opisal Simon na ventralni in stranski zadnji površini medvretenčnih ploščic pri obešencih, so kasneje opazovali tudi v primerih smrti zaradi vzrokov,

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ki niso bili povezani z obešanjem, vendar so prišli do zaključka, da se tovrstne krvavitve ne pojavljajo v primerih posmrtnega obešenja. Rezultati, ki smo jih dobili po oceni vseh skupin, ne potrjujejo hipoteze, da incidenca Simonove

krvavitve s starostjo upada. Nasprotno, pri primerjavi vseh ostalih skupin je bila incidenca Simonove krvavitve tudi pri obešencih z najvišjo povprečno starostjo višja.

## Introduction

Hanging is a lethal suspension of a person by a ligature where one end of the rope is tied to a fixed point above the neck, and the other end is looped or knotted around the neck, which kills the victim by gravity forces, and body weight imposed on the neck region.<sup>1,2</sup> Episodes of hanging are usually of suicidal origin, however accidental, and criminal cases have been also reported.<sup>3–6</sup> Ligature marks are generally detected above the thyroid cartilage, and they are seen because of postmortem water loss from the corpse.<sup>2,7</sup> To determine whether or not hanging had taken place before or after the death of the victim is quite important in the identification of the criminal cases pretended to be suicidal attempts. Traumas imposed upon internal cervical structures, such as vascular and muscular injuries of the neck, fractures of hyoid bone, and thyroid cartilages secondary to direct, and indirect impact of compression incurred upon certain region of the neck are considered as the clues to the vitality of the victim during hanging.<sup>7–9</sup> However, it has been reported that without the presence of these signs, intravital reactions could manifest during procedure of hanging or these signs could be seen during the postmortem period.<sup>10</sup> In various investigations performed, different incidences have been reported for fractures of thyroid cartilage, hyoid bone, and soft tissue bleedings,<sup>6,8,9,11</sup> and an increased frequency of neck bone fractures has been associated with advanced age,<sup>8,11</sup> and longer hanging periods.<sup>12,13</sup> Because of these discrepancies and postmortem artifacts, investigators have proposed new findings possibly favouring vitality in cases of hanging. Among them, higher postmortem thyroglobulin levels,<sup>14</sup> accumulation of pulmonary surfactants as

detected during histopathological examinations,<sup>15</sup> higher stress hormone (adrenalin, and noradrenalin) levels,<sup>16</sup> detection of traces of tryptase, IL -15 and CD15 on ligature marks during immunohistochemical analysis,<sup>10</sup> and pneumomediastinum and soft tissue emphysema of the neck in CT and/or MRI can be enumerated.<sup>17</sup> However, firstly in 1968, Simon et al. identified bleeding foci on the dorsal and ventral aspects of the intervertebral discs of the spinal column in cases of hanging.<sup>18–19</sup> In further studies, these bleeding foci were not found to be specific to the cases of hanging, and they were considered as antemortem evidence.<sup>7,20–22</sup> In the light of these findings, Simon's bleeding can be an indicator of vitality, however because of variations of its incidence in cases of hanging, and observation of these signs in deaths due to various causes, many dilemmas concerning mechanism(s) of these types of bleedings, specificity of these findings in relevant assessments, and their contribution (if any) to the forensic evaluation of cases of hanging have to be clarified explicitly. In our study, we aimed to determine the frequency of Simon's bleedings seen in the lumbar spinal column in cases of death due to hanging, asphyxiations, strangulations, drowning, physical injuries (electrocution, traffic accidents, falls etc.), intoxications with carbon monoxide, as well as in deaths not related to asphyxiation, and possible relationship of this type of bleeding episodes with age. We also intended to investigate whether or not Simon's bleedings can be evaluated as a sign of vitality in hanging.

## Material and method

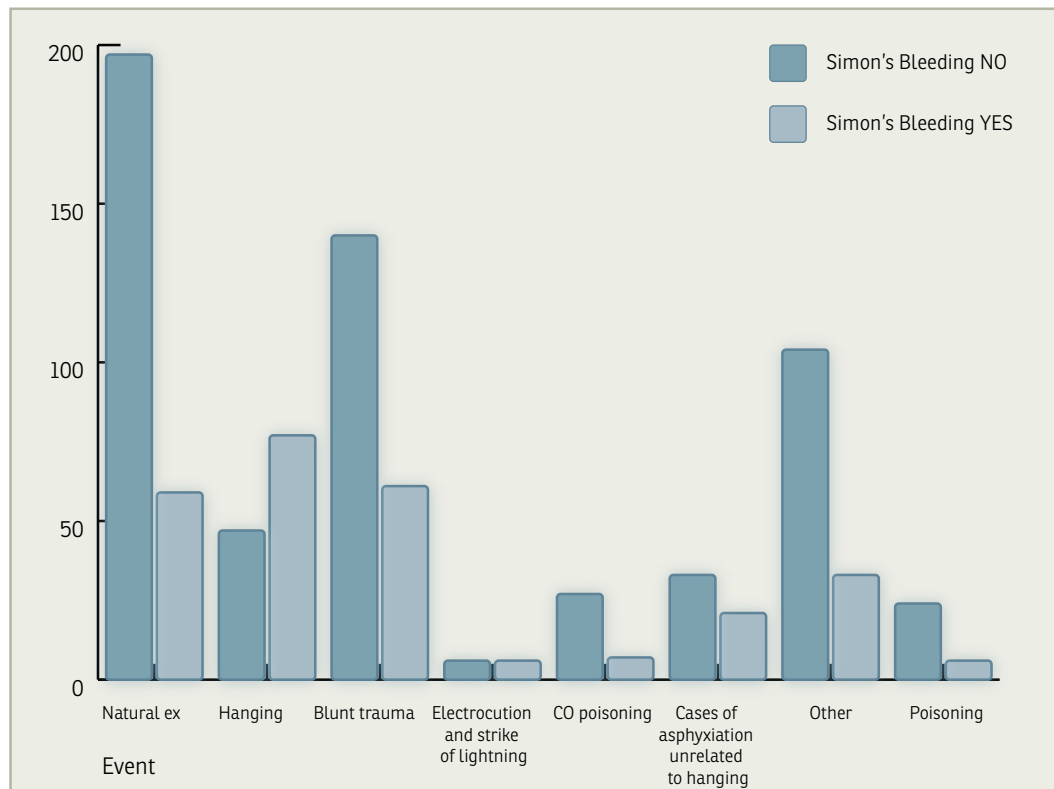
The cases autopsied in Bursa Morgue Department between 2009 and 2011 were investigated and evaluated retrospectively. The evidence of Simon's bleeding was sought in cases included in the study group after retracting soft tissue and organs away from the field of interest for full exposure of the region of lumbar spinal vertebrae without macroscopic grading of the severity of bleeding, and determining the lumbar level of bleeding. Study group consisted of sudden death cases, and cases of death found shortly

before the event or manifestation of typical symptoms. Only suicidal cases of hanging were included in the study group, cases of hangings performed while sitting erect or in the supine position were not considered in the study. Time interval between the event of death and autopsy ranged between 12–24 hours. Extremely decayed corpses were excluded from the investigation. The cases were evaluated for the presence of Simon's bleeding, cause of death, and age of the deceased.

**Table 1:** Autopsy findings related to Simon's bleeding, age, and cause of death

Event		Age groups (years)								Total
		<=20	21–30	31–40	41–50	51–60	61–70	71–80	>80	<=20
Natural ex	no	13	10	24	34	36	42	31	7	197
	yes	2	7	7	13	15	7	6	2	59
	Total	15	17	31	47	51	49	37	9	256
Hanging	no	3	9	9	4	10	9	2	1	47
	yes	10	13	13	15	12	4	8	2	77
	Total	13	22	22	19	22	13	10	3	124
Blunt trauma	no	11	28	23	28	20	14	10	6	140
	yes	5	10	9	11	11	6	7	2	61
	Total	16	38	32	39	31	20	17	8	201
Electrocution and lightning strike	No	1	0	0	2	1	2			6
	Yes	0	2	2	1	0	1			6
	Total	1	2	2	3	1	3			12
CO poisoning	No	5	5	3	2	2	3	5	2	27
	Yes	3	2	0	0	0	1	1	0	7
	Total	8	7	3	2	2	4	6	2	34
Asphyxiation	No	6	7	3	2	6	6	3		33
	Yes	6	2	3	2	3	3	2		21
	Total	12	9	6	4	9	9	5		54
Other	No	16	17	27	18	12	6	6	2	104
	Yes	4	5	8	6	7	3	0	0	33
	Total	20	22	35	24	19	9	6	2	137
Poisonings	No	2	4	2	4	6		5	1	24
	Yes	0	0	1	2	2		0	1	6
	Total	2	4	3	6	8		5	2	30

**Figure 1:** Presence of Simon's bleeding according to the causes of death.



### Statistical analysis

Statistical analysis was performed using SPSS 19.0 version for windows program. Continuous variables were presented on the basis of average, standard deviation, median and range. Pearson chi-square tests were used for the comparison of the distributions of categorical variables between groups. After checking the normality assumptions for the continuous variables, Kruskal-Wallis test and Mann-Whitney U test were used for the comparisons as nonparametric tests. Pairwise comparisons were done with Bonferroni adjustment ( $p < 0.0083$ ) to make sure that the family-wise alpha would not exceed 0.05. A  $p < 0.05$  was considered significant except in pairwise comparisons.

### Results

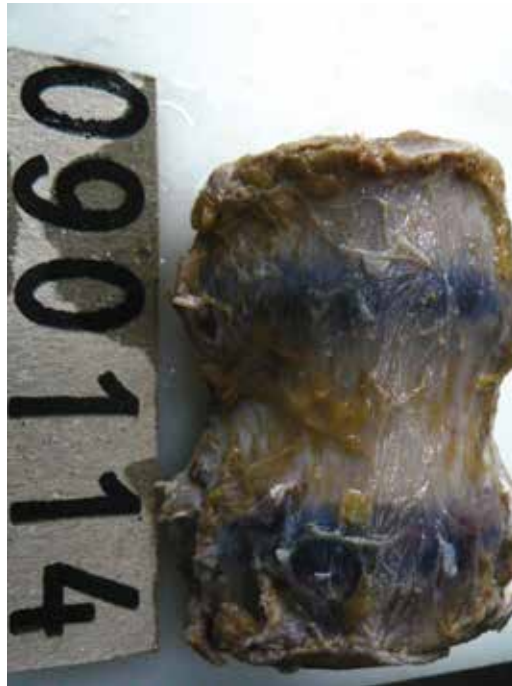
A total of 848 cases (664 males, and 184 females, male/female ratio, 3.6 :1) were included in the study. Mean ages of women and men were  $45.9 \pm 18.9$ , and  $47.7 \pm 22.8$  years, respectively ( $p > 0.05$ ). The distribution of autopsy findings related to Simon's bleeding, age, and cause of death is presented in Table 1. A total of 124 cases of hanging

(14.6 %) were included in the study. We also observed cases of electrocution ( $n = 12$ ), CO poisoning ( $n = 32$ ), and asphyxiation unrelated to hanging ( $n = 54$ ) amounting to 100 cases (11.8 %). Blunt trauma accounted for the death of 201 cases. Among 256 cases of natural death, there were 31 cases (12.1 %) of sudden cardiac death. A total of 270 (31.8 %) cases had Simon's bleeding.

Distribution of deaths with or without Simon's bleeding according to causes of death are presented in Figure 1. A significant difference in the frequency of Simon's bleeding exists among various causes of death. 28.5 % ( $n = 77$ ) of the cases with Simon's bleeding (Figure 2) were in the group of death cases due to hanging ( $p < 0.001$ ).

According to the results of analysis performed for age at death, there was no significant difference between median ages of the cases with or without Simon's bleeding ( $p > 0.05$ ). Among median ages of four event groups, a statistically significant difference was found ( $p < 0.001$ ) with the smallest, and the highest mean ages were encountered in deaths by causes of asphyxiation unrelated to hanging and natural deaths ( $42.33 \pm 22.27$ , and  $52.63 \pm 18.78$  years,

**Figure 2:** Simon's bleedings on the intervertebral discs of the lumbar vertebrae.



respectively). Median ages of natural causes were statistically significantly higher when compared with death cases due to blunt trauma, hanging and asphyxiation unrelated to hanging ( $p < 0.001$ ,  $p < 0.001$ , and  $p < 0.001$ , respectively (Table 2).

## Discussion

Splinter bleedings identified originally by Simon in 1968, on the ventral and later dorsal aspects of the spinal discs in cases of hanging<sup>18,19</sup> were also observed later in deaths unrelated to hanging,<sup>7,20,21</sup> however it was concluded that these types of bleeding could not be detected in cases of postmortem hanging.<sup>22</sup> In separate studies performed by Geserick et al. in 1976 (retrospective design, 29.2 % of 840 cases),<sup>21</sup> Saternus et al. in 1979 (56 % of 32 cases),<sup>23</sup> Kleiber et al. in 1982 (47 % of 222 cases),<sup>24</sup> Nikolic S et al. in

**Table 2:** Correlation between mean ages of deceased cases with and without Simon's bleedings and the causes of their deaths.

Age (years)

Event Group	Simon's Bleeding	n	Mean	Std. Deviation	Median	Min.	Max.	p-value	Post-Hoc ***
Natural Death <sup>a</sup>	No	197	53,12	19,33	56	0	89	* $p < 0.001$ ** $p > 0.05$	a-b $p < 0.001$ a-c $p < 0.001$ a-d $p < 0.001$
	Yes	59	50,98	16,87	51	17	89		
	Total	256	52,63	18,78	54	0	89		
Hanging <sup>b</sup>	No	47	45,47	18,29	49	14	81		
	Yes	77	43,42	19,36	43	9	85		
	Total	124	44,19	18,92	44	9	85		
Blunt trauma <sup>c</sup>	No	140	44,39	20,12	42	1	94		
	Yes	61	46,30	20,0	47	7	86		
	Total	201	44,97	20,05	43	1	94		
† Cases of asphyxiation unrelated to hanging <sup>d</sup>	No	66	44,29	22,53	43	2	89		
	Yes	34	38,53	21,58	36,5	8	78		
	Total	100	42,33	22,27	40	2	89		
Total	No	450	48,31	20,35	49	0	94		
	Yes	231	45,39	19,58	47	7	89		
	Total	681	47,32	20,13	48	0	94		

† – Asphyxiations unrelated to hanging, Electrocutation and CO poisoning

\*p- Kruskal-Wallis H test

\*\*p- Mann-Whitney U test

\*\*\*p- Mann-Whitney U test with Bonferroni correction



2009 (prospective design, 62.8 %) reported the presence of Simon's bleedings in cases of hanging as indicated within respective parentheses. However, in our study, Simon's bleeding was observed in 31.8 % of total 848 cases and in 62.1 % of hanging cases. The presence of Simon's bleeding demonstrates a significant difference with respect to causes of death. Seventy seven (28.5 %) cases with Simon's bleeding were seen in the hanging group ( $p < 0.001$ ). These types of bleedings were also observed in cases of death secondary to mechanical asphyxia unrelated to hanging (21/54; 38.8 %), electrocution and lightning strike (6/12; 50 %), and carbon monoxide poisoning (7/34; 20.6 %). Simon's bleedings were noted in 34 % (34/100) of death cases caused by asphyxiation unrelated to hanging. In contrast to the results obtained by Nikolic S et al.,<sup>7</sup> a significant difference was revealed when the frequency of Simon's bleeding among cases of hanging, mechanical asphyxia, and all cases of asphyxia irrespective of their etiologies were compared ( $p < 0.001$ ). According to our results, Simon's bleedings also developed in other types of asphyxiated deaths, but their incidence was significantly higher in cases of hanging. In a study performed by Nikolic S et al.,<sup>7</sup> Simon's bleedings had been detected in 33 of 214 (15.4 %) cases of natural death, however in our study Simon's bleeding was encountered in 59 of 256 (23 %) deaths due to natural causes whose incidence was considerably lower when compared to hanging cases ( $p < 0.001$ ). As can be seen in cases with blunt trauma, Simon's bleedings reported in various studies<sup>7,20,25</sup> were seen in 61 out of 201 cases of blunt trauma evaluated in our study. In this group, Simon's bleeding was most frequently detected in traffic accidents, which was seen in 21 of our 57 cases. In a study performed by Nikolic S et al. it was reported that underlying mechanism of Simon's bleeding seen in cases of hanging is similar, but not identical to that observed in other asphyxiated cases whose possible mechanism of occurrence might be coercive movement of spinal column due to agonal convulsions.<sup>7</sup> Still in this study<sup>7</sup> it was stated that Simon's bleedings in cases of hanging proposed by Saternus et al.<sup>23</sup> had stemmed

from caudo-rostral hyperextension of the spinal column due to traction forces effective during the period of hanging in addition to forces of gravity. However, it was emphasized that in cases of blunt trauma forces imposed solely on the spinal cord are quite different from those detected in cases of hanging, though basically coercive extensions or flexions of the spinal column might induce these types of bleeding.<sup>7</sup> Nikolic S et al. evaluated all of their cases, and indicated a decrease in the incidence of Simon's bleeding with age.<sup>7</sup> Still they had suggested that in cases of hanging, a statistically significant difference existed between groups with and without bleeding, with a decrease in the incidence of Simon's bleeding in age groups over 55 (the frequency of nonobservance of Simon's bleedings is 70 % and 88 % in death cases over 60 and 70 years of age, respectively), and asserted that these outcomes obtained were associated with degenerative changes in the lumbar spinal column characterized by restricted mobility inherent to the region's biomechanical properties.<sup>7</sup> Contrarily, Saternus et al. had indicated absence of any correlation between Simon's bleedings, age, and degenerative changes in the spinal column.<sup>23</sup> All cases of our study group ( $n = 848$ ) and hanging cases were subjected to intragroup evaluations, and consequently any statistically significant difference between mean ages of those with or without Simon's bleedings could not be found ( $p > 0.05$ ). A statistically significant difference was detected between mean ages of the deceased when categorized according to causes of death ( $p < 0.001$ ). Mean ages of hanged victims were statistically significantly higher ( $52.63 \pm 18.78$  years) when compared to cases of asphyxiation, blunt trauma, and natural death ( $p = 0.001$ ,  $p < 0.001$ , and  $p < 0.001$ , respectively). When we evaluated all groups, our results do not support the assertion that the incidence of Simon's bleeding decreases with aging. Instead, when compared to all other groups, the incidence of Simon's bleeding was also higher in cases of hanging with the highest mean age. However, when hanging cases were evaluated among themselves, no correlation between age and the incidence of Simon's

bleeding could be observed. Therefore, the mechanism of the onset of Simon's bleeding suggested by Nikolic does not explain the result that we obtained. As indicated by Saternus et al., we think that Simon's bleeding does not correlate in any way with age and

degenerative changes in the spinal column. In conclusion, further studies are needed to elucidate the mechanism of the onset of Simon's bleedings, and their possible use as a specific sign of vitality.

## References

1. Knight B, Saukko P. Knight's Forensic Pathology. CRC press; 2004.p. 383.
2. Di Maio VJ, Di Maio D. Forensic pathology. 2nd edn. CRC, Boca Raton: CRC Press; 2001. p. 229–77.
3. Ambade VN, Godbole HV, Kukde HG. Suicidal and homicidal deaths: a comparative and circumstantial approach. *J Forensic Leg Med.* 2007; 14: 253–60.
4. Sharma L, Khanagwal VP, Paliwal PK. Homicidal hanging. *Leg Med (Tokyo).* 2011; 13: 259–61
5. DiMaio VJ. Homicidal asphyxia. *Am J Forensic Med Pathol* 2000; 21: 1–4.
6. Azmak D. Asphyxial deaths: a retrospective study and review of the literature. *Am J Forensic Med Pathol.* 2006; 27: 134–44.
7. Nikolić S, Zivković V, Juković F, Babić D, Stanojkovski G. Simon's bleedings: a possible mechanism of appearance and forensic importance-a prospective autopsy study. *Int J Legal Med.* 2009; 123: 293–7.
8. Nikolic S, Micic J, Atanasijevic T et al. Analysis of neck injuries in hanging. *Am J Forensic Med Pathol.* 2003; 24: 179–182.
9. Uzun I, Buyuk Y, Gurpinar K. Suicidal hanging: fatalities in Istanbul: retrospective analysis of 761 autopsy cases. *J Forensic Leg Med.* 2007; 14: 406–409.
10. Turillazzi E, Vacchiano G, Luna-Maldonado A, Neri M, Pomara C, Rabozzi R, Riezzo I, Fineschi V. Tryptase, CD15 and IL-15 as reliable markers for the determination of soft and hard ligature marks vitality. *Histol Histopathol.* 2010; 25: 1539–46.
11. Betz P, Eisenmenger W. Frequency of throat-skeleton fractures in hanging. *Am J Forensic Med Pathol.* 1996; 17: 191–193.
12. Simonsen J. Patho-anatomic findings in neck structures in asphyxiation due to hanging: a survey of 80 cases. *Forensic Sci Int.* 1988; 38: 83–91.
13. Morild I. Fractures of neck structures in suicidal hanging. *Med Sci Law.* 1996; 36: 80–84.
14. Senol E, Demirel B, Akar T et al. The analysis of hormones and enzymes extracted from endocrine glands of the neck region in deaths due to hanging. *Am J Forensic Med Pathol.* 2008; 29: 49–54.
15. Zhu BL, Ishida K, Fujita MQ, Maeda H. Immunohistochemical investigation of pulmonary surfactant in fatal mechanical asphyxia. *Int J Legal Med.* 2000; 113: 268–271.
16. Wilke N, Jansen H, Fahrenhorst C et al. Post-mortem determination of concentrations of stress hormones in various body fluids—is there a dependency between adrenaline/noradrenaline quotient, cause of death and agony time? *Int J Legal Med.* 2007; 121: 385–394.
17. Aghayev E, Yen K, Sonnenschein M et al. Pneumomediastinum and soft tissue emphysema of the neck in postmortem CT and MRI; a new vital sign in hanging. *Forensic Sci Int.* 2005; 153: 181–188.
18. Simon A, Vitale Reaktionen im Bereich der Lendenwirbelsäule beim Erhängen, *Wiss Z Univ Halle* 1968; 17: 591–597.
19. Simon A, Weitere Beobachtungen vitaler Reaktionen im Bereich der Lendenwirbelsäule, *Aktuelle Fragen Gerichtl. Med.* 1968; 3: 297–299.
20. Brinkmann B, Madea B. *Handbuch gerichtliche Medizin.* Berlin: Springer; 2004. p. 797–824.
21. Geserick G, Lignitz E, Patzelt D. Zum Aussagewert von ventralen Bandscheibenblutungen. *Beitr Gerichtl Med* 1976; 34: 259–263.
22. C. Kerde, Heuschkel HJ. Zur Problematik der Diagnose "Erhängen" - *Kriminal forens Wiss* 1971; 4: 17–25.
23. Saternus KS, Dotzauer G, Imhauser G. The importance of Simon's symptom in cases of hanging. *Z Rechtsmed* 1979; 83: 283–289.
24. M. Kleiber, E. Koops, K. Puschel, J. Gottberg, B. Brinkmann. Zur Pathologie des Erhängens unter besonderer Berücksichtigung vitaler Reaktionen. *Beitr Gerichtl Med* 1982; 40: 117–121.
25. Lignitz E, Henn V. New autopsy signs in violent death. *Forensic Sci Int* 2007; 165: 172–177.