

Causes of Death Accompanying by Soft Tissue Neck Hemorrhage

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ABSTRACT

Background: Generally, soft tissue hemorrhages in anterior part of the neck are attributed to the neck compression or trauma and suspicion goes more to homicidal death than suicide. Although artificial posterior neck hemorrhages are described as Prinsloo-Gordon phenomenon in cadavers with posterior lividity, studies conducted on such hemorrhages in the anterior and lateral compartments are rare. This study intends to investigate causes of death accompanied by soft tissue neck hemorrhages in different compartments of neck.

Method: In this retrospective case series, between March 2008 and 2009, cadavers whose autopsies indicated soft tissue neck hemorrhages and the lividity was dominant in posterior, were evaluated according to the cause of death and anatomical and histological locations of hemorrhage.

Results: Among 86 cases of neck hemorrhage, 72.1% (n=62) were male. Direct neck trauma, hanging, strangulation, choking and positional asphyxia constituted 50% (n=43) of them, 40.7% (n=35) were non-asphyxial, non-traumatic deaths such as natural diseases, drug and CO poisoning, electrocution and drowning, and 9.3% (n=8) were unknown. 65.1% (n=28) of non-traumatic, non-asphyxial cases bore anterior or lateral neck hemorrhages.

Conclusion: The considerable prevalence of soft neck tissue hemorrhages in non asphyxial deaths with no history of neck trauma and the location of such hemorrhages in anterior and lateral sides of neck, lead the investigators to pay more attention to interpret these hemorrhages and determining the mode and cause of death.

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► *Implication for health policy/practice/research/medical education:*
Causes of Death Accompanying by Soft Tissue Neck Hemorrhage

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1. Introduction:

The objective to conduct autopsy is to establish the cause of death and differentiate between natural and criminal deaths. An autopsy is branded as

successful when the injuries leading to death are well recognized and accurately interpreted. The interpretation of the findings would be more important when signs of unnatural death are found during a classic autopsy. Neck hemorrhage including subcutaneous, intramuscular, and laryngeal mucosa bleedings are unnatural and considered as known symptoms of asphyxia resulting from external pressure on the neck. These symptoms frequently lead doctors to ascertain neck compression as a cause of death. Although neck hemorrhage is the main diagnostic symptom for neck compression, in many cases there is no finding despite the exertion of external pressure. In previous studies conducted on hanging, more than half of the cases had no hemorrhage in the neck region (1-3). Intra muscular neck hemorrhage is the most common finding in manual strangulation and sometimes in ligature strangulation. These findings are well documented in mechanical asphyxia (4-6). Due to the higher prevalence of these hemorrhages in homicidal rather than suicidal death (1-4), there are more convincing reasons to establish homicide as the cause of death which complicates the judgment.

The important question is whether all hemorrhages in the soft tissues of the neck found through autopsies could be attributed to asphyxiation or neck trauma? Prinsloo and Gordon in 1951 reported the collection of blood between the esophagus and cervical spine in bodies with posterior lividity, a phenomenon recognized as an artifact, especially when autopsies are delayed (7). Other studies on non-asphyxial death, have also reported some hemorrhages in various parts of the neck and tongue muscles without any symptoms of neck compression. These hemorrhages have also been reported in natural deaths (8), post cardiopulmonary resuscitation (CPR) (9), drowning (10, 11), and burning (12, 13), and have also been described as an extravasation phenomenon in

postmortem hypostatic hemorrhages (14), but still are controversial.

Further data collection to investigate the causes of death which could induce neck hemorrhage or bruise, are helpful to differentiate these atypical cases from the classic causes of neck hemorrhage. To the best of our knowledge, previous studies limitedly focused on neck hemorrhage in one specific cause of death like drowning. The present study evaluates the various causes of death in all autopsies with bleeding in neck soft tissues with considering anatomical and histological site of hemorrhage.

2. Materials and Methods:

This is a routine data base study evaluated files of the deceased referred to the Tehran Province Forensic Medicine Commission between March 2008 and March 2009. In Iranian Legal Medicine Organization the autopsies are performed in morgue department and after analysis the results of pathology and toxicology tests, cases which are complicated and need more attention are referred to the Province Forensic Medicine Commission with trained forensic medical doctors in various fields of specialty like forensic pathology, surgery and psychology. Each case is discussed in a meeting attended by at least 3 to 5 experts and the cause of death will be assigned after reviewing all documents. Among 1132 referral cases, the files which had gross or microscopic hemorrhages in neck soft tissues were included. The files with incomplete diagnostic data about toxicology, pathology, autopsy, previous clinical history and police documents, and files which had criminal suspicions of pressure on neck were excluded from the study, except the cases which had coordination between the cause of death and neck injury. Moreover, to avoid iatrogenic neck hemorrhage, all cases which the neck was dissected before brain removal were excluded. Finally, 86 cases were included. Hemorrhages in the neck were classified in two categories, anatomical and histological. The anatomic

Table 1: The frequency distribution of cause of death in relation to age and gender.

Cause of death	Mean age	Male	female	total
Hanging	34± 16.1	9 (14.5%)	10 (41.7%)	19 (22.1%)
Neck trauma	36.7± 15.8	12 (19.4%)	2 (8.3%)	14 (16.3%)
Cardiovascular disorder	50.6± 9.4	11(17.7%)	0 (0%)	11(12.8%)
Strangulation	35± 21.8	5 (8.1%)	3 (12.5%)	8 (9.3%)
Unknown	32.5± 6.0	7 (11.3%)	1 (4.2%)	8 (9.3%)
Drug abuse	29.5± 11.1	4 (6.5%)	2 (8.3%)	6 (7%)
Co poisoning	23.3± 4.3	4 (6.5%)	2 (8.3%)	6 (7%)
Burning	50± 24.7	2 (3.2%)	3 (12.5%)	5 (5.8%)
Respiratory failure	34.1± 22	3 (5.8%)	1 (4.2%)	4 (4.8%)
Drowning	36± 15.5	2 (3.2%)	0 (0%)	2 (2.3%)
Choking	77	1 (1.6%)	0 (0%)	1(1.2%)
Electrocution	33	1(1.6%)	0 (0%)	1 (1.2%)
Positional asphyxia aasasasphh	34	1 (1.6%)	0 (0%)	1 (1.2%)
total	36.4± 16.4	62	24	86

locations were divided into five regions: posterior, anterior, lateral, posterolateral and anterolateral. There were three histological regions of hemorrhage: subcutaneous areas, muscles of the neck and tongue, and laryngopharyngeal mucosa. The causes of deaths were established through the revision of the information in the respective files, investigating the medical records of the deceased, photos taken from the cadavers, autopsy reports, results of the toxicological and pathological exams, and interviewing family members and anyone who had some information about the body conditions at the time of death. The collected data were analyzed using SPSS 13. The quantitative variables were evaluated with mean, median and standard deviations and the qualitative data were evaluated with frequency distribution.

3. Results:

Among 86 autopsies, 24 (27.9%) were female and 62 (72.1%) were male. The range of age was between 16 to 72 years old with a mean of 36.4±16.4 years; however, the highest frequency belonged to cases in the third decade of life at 31.4% (n=27). The most frequent cause of death was hanging and the least frequent were choking, positional asphyxia and electrocution. The prevalence of causes of death in terms of sex frequency is shown in Table 1.

In our study 50% (n=43) of neck hemorrhages belonged to direct neck trauma and asphyxial death (hanging, strangulation, positional asphyxia, choking). 40.7% (n=35) of cases were due to infrequent reasons of neck hemorrhage such as drug abuse or CO-poisoning, and 9.3% (n=8) remained unspecified in spite of all investigations but they have no

Table 2: Frequency of neck hemorrhage according to cause of death and histology.

tissue	Muscles	subcutaneous	mucosa	Total
Cause				
Hanging	17(89.4%)	7(36.8%)	3(15.8%)	19
Neck trauma	10(71.4%)	6(42.9%)	0	14
Strangulation	8(100%)	2(25%)	1(12.5%)	8
Choking	1(100%)	0	0	1
Positional asphyxia	1(100%)	0	0	1
Cardiovascular disorders	6(54.5%)	2(18.2%)	5(45.5%)	11
Drug overdose	5(83.3%)	0	3(50%)	6
Co poisoning	3(50%)	0	3(50%)	6
Burning	3(60%)	1(20%)	2(40%)	5
Respiratory failure	4(100%)	1(16.7%)	4(50%)	4
Drowning	1(50%)	0	1(50%)	2
electrocution	0	0	1(100%)	1
Unknown	3(37.5%)	1(12.5%)	4(50%)	8
total	62(72%)	20(23.2%)	27(31.3%)	86

history and sign of trauma in external and internal examination. Soft tissue neck hemorrhage in relation to the histological category was mostly seen in muscles of the neck and tongue (61 cases), among which 26 cases had hemorrhage in pharyngeal mucosa and 20 cases had subcutaneous hemorrhage. In some cases hemorrhages were seen in more than one site. The frequency of hemorrhage in relation to the

cause of death histology is shown in Table 2.

The anatomical locations of hemorrhages in the neck were classified into 3 main regions (posterior, anterior, lateral aspect of neck) and two combination regions (posterolateral and anterolateral). We did not find any other combination through autopsy reports. Eventually, 44.2% (n=38) of hemorrhages were in the lateral neck, 25.6% (n=22) posterior, 20.9% (n=18)

Table 3: The locations of neck hemorrhages with regards to infrequent causes of neck hemorrhage.

	lateral	Anterior	Posterior	Anterior & lateral	total
Drug abuse	3	0	2	1	6
Respiratory insufficiency	1	3	0	0	4
CO poisoning	2	2	2	0	6
Cardiovascular disorders	4	1	5	1	11
Burning	3	0	2	0	5
Drowning	1	1	0	0	2
Electrocution	0	0	1	0	1
Unknown	4	1	3	0	8
total	18(41.8%)	8(18.6%)	15(34.8%)	2(4.6%)	43(100%)

anterior, 8.1% (n=7) posterolateral, and 1.2% were anterolateral hemorrhages.

The location of neck hemorrhages in asphyxia and direct neck trauma included 46.5% (n=20) lateral, 32.5% (n=14) anterior, 11.6% (n=5) anterolateral, 6.9% (n=3) posterior, and 2.3% (n=1) posterolateral. Table 3 shows the anatomical distribution of neck hemorrhage in other causes of death. In these cases the lateral compartment of the neck was the most prevalent site of hemorrhage, and the posterior compartment was second most prevalent.

4. Discussion:

The findings of the present study show that medical errors are considered by more than 90% of physicians to be one of the most salient problems of healthcare systems. Nevertheless, disclosure of medical errors can be an awkward act for physicians. The findings also indicate that more than half of physicians believe that the disclosure of medical errors could be a threat to patient trust in the physician. In contrast, previous studies show that negligence of the

medical staff in the disclosure of medical errors ensues patient distrust (17-19) and the full disclosure of the errors may not only leave patient trust intact but it may also boost it (12). This may emanate from patients' belief in the integrity of the physician in exerting every effort to save or treat them. In other words, the nondisclosure of the occurrence of the medical errors is not only an instance of infringement of medical ethics (12) but also is viewed by patients as an act of dishonesty and the irresponsibility of the physicians in their practice.

It is also shown that more than a quarter of physicians expressed support for the disclosure of serious medical errors while only half of the participants supported the disclosure of minor and near miss medical errors. Previous studies have produced mixed results in this regard. Other studies, in line with the present one, have shown most physicians in support of the disclosure of serious medical errors (20) and few in favor of full disclosure of the different types of medical errors to the patients (21). On the contrary, other

studies have shown that physicians believe that patients are entitled to receive full details of the occurrence of undesirable medical incidents (22). In addition, other studies have shown that 96% of physicians have asserted that they would report even the occurrence of minor medical errors to their patients (23). Although many physicians consider the disclosure of near miss medical errors to the patients impractical (24), in reality the existing standards make no exemptions about the disclosure of any type of medical errors (25). It seems that the appropriate method in the treatment of non-serious errors, as in near miss medical errors, is the notification of the patients who are willing to know about the occurrence and follow-up of those errors (24).

Although three out of four physicians in the study supported the declaration of occurrence of medical errors to the ward or hospital authorities, only half of them supported notification of their colleagues. In-depth follow-up studies show that committing medical errors places the medical staff in a vicious cycle of personal criticism and legal prosecution, creating a state of estrangement and doubt in addition to the consequences of those errors which are obstacles to the optimal measures expected to be adopted after the occurrence of such medical errors. Evidence shows that consultation and mutual relationship with authorities and colleagues are the best and most efficient solution for the selection of the best options in such situations. Today it still appears that the required advice and support are offered in a subjective manner (26) while an accurate planning and need for the development of well-thought out behaviors and acts by the physicians is strongly felt.

The present study shows that fear of patient's suing, unfamiliarity with patient's temperament and reaction and fear of patient's anger over realizing the occurrence of the medical error are the major deterrents to the nondisclosure of medical errors by the physicians. In line

with the findings of the present study, other studies have shown that patient suing is the major deterrent in the nondisclosure of the medical errors. This common finding across several studies seems to be the most controversial obstacle to the disclosure of medical errors by physicians (13, 27-29).

Although the findings in the present study indicate no significant difference between the attitudes of the physicians in terms of sex and age group, differences were found between the attitudes of internists and surgeons in relation with the disclosure of medical errors. Significantly more than the internists did the surgeons believed that the disclosure of medical errors would reduce the likelihood of patient suing and that the occurrence of the medical errors need to be declared to the authorities and colleagues as well. Although previous studies have not produced any evidence, the different characteristics of participants, including their sex, age and even specialty, would warrant disparity of attitudes towards the disclosure of medical errors. Therefore, it seems that conducting similar studies but at a larger scale and on different specialties would contribute to the acquisition of basic data for use in the development of more efficient intervention programs.

Although the present study is the first of its kind in Iran to investigate the attitudes of medical staff towards the disclosure of medical errors, limitations such as a small sample size, exclusion of disclosure level and the use of closed question items on the questionnaire may count as the limitations of soft tissue neck hemorrhage has been described in direct and indirect neck traumas and some types of asphyxial death like hanging and strangulation. Bleeding occurs after death if blood vessels, engorged by blood postmortem, rupture. Contributory factors include increased pressure caused by body position, early decomposition, and trauma (15). Postmortem hypostatic hemorrhages may develop in the anterior side of the neck in cases which lividity was fixed in the prone position (14). Although soft tissue

hemorrhages, especially with inflammatory cells, are signs of vital reaction; however it is possible to occur after death (16-17).

In this study, in addition to the expected causes of neck hemorrhage, some other causes have been observed. Out of 86 autopsies with neck hemorrhage, only half had died due to asphyxia and neck traumas. In 40.7% (n=35) of cases, neck hemorrhage was observed with other causes of death such as drug overdose, respiratory insufficiency, CO-poisoning, advanced cardiac diseases, burning, electrocution and drowning. The cause of death in 9.3% (n=8) of cases which had no symptom of trauma to any parts of the body especially the neck, could not be established in spite of various investigations. However, our cases were selected among files that were referred to the highly specialized centers of legal medicine, so the frequency of causes of death and sex may not conform to the normal population.

Hanging and other neck compressions are known causes of neck hemorrhage. In the present study hanging was the most frequent cause of neck hemorrhage (22.1%) which could be due to the high prevalence of hanging among other asphyxial deaths. In a related study on 134 asphyxial deaths in Turkey, Azmak reported that the most frequent (41.8%) type of asphyxial death was hanging (6). In hanging, soft tissue or intramuscular neck hemorrhage have been reported in 3% to one-third of cases (1, 2).

Neck hemorrhage is one of the most common findings in strangulation (6), and in over 80% of homicidal strangulations, neck hemorrhages have been observed in autopsy (15). We found neck hemorrhages caused by hanging and strangulation only in the anterior and lateral neck, and not in the posterior neck. Since the lividity was fixed on the back side, these hemorrhages do not seem to be artificial. Mucosal hemorrhages were observed in 15.8% of hanging and 12.8% of strangulation cases. As reported by other studies, laryngeal

hemorrhages of the mucosal lining, most often seen immediately below the vocal cord, may show pressure on the neck (18). Maxeiner reported 68 submucosal hemorrhages among 110 strangulation and blunt neck trauma cases. He also estimated 5.5% frequency of mucosal hemorrhage in natural deaths, mostly petechiae and caused by congestion (19). Another study on 191 cases of homicidal strangulation showed 60% mucosal hemorrhage (20).

Although submucosal hemorrhages are approximately as frequent in neck compression and especially in strangulation, our study showed less frequency in hanging and strangulation than other causes of death such as drug abuse, CO-poisoning, and cardiovascular diseases. However, it was observed in all causes of deaths except choking and direct neck trauma. In this study only 19% (n=5) of submucosal hemorrhages were due to asphyxial deaths and neck trauma, and the remaining belonged to other reasons. This study has a low sample size to discuss about sex in different causes of death.

Drowning is one of the misleading causes of neck hemorrhage, and observing hemorrhage does not exclude drowning as a cause of death however the occurrence of petechiae and neck hemorrhage in a body recovered from the water is still controversial (21). These hemorrhages are organized in head down prone position during lividity formation, however hemorrhage may result from violent neck movements during the process of drowning and it does not always indicate compression of the neck (11, 15, 22). Püschel K *et al* reported 14 cases of drowning with macroscopic intramuscular hemorrhage with no subcutaneous bruising, of which light microscopy examination showed a vital type of muscular alteration in 50%. They believed that this muscular alteration may attribute to agonal convulsion and hyper contraction and overexertion of the affected muscles (22). We found only two drowning cases which the lividity was dominant in posterior aspect of neck but the

intramuscular and submucosal hemorrhage were in anterior and lateral compartments of the neck, and no subcutaneous bleeding was detected.

Our study included 11 cases of death caused by advanced cardiac diseases such as ischemic heart disease or cardiac failure and 4 cases of respiratory failure. All of them underwent CPR in hospitals. Although neck hemorrhages are not commonly observed in natural deaths, little has been reported in earlier studies. Lach *et al* have reported 5 cases of hemorrhage in gross and microscopic investigations of neck muscles, shoulder girdle, and the back of the thorax. All of these cases showed no signs of violent crime or trauma to the neck, and the cause of death in all were associated with internal diseases. Their study suggests the intensified breathing with dyspnea leading to accessory respiratory muscles rupture and hemorrhage (8).

Bruising, hemorrhage and abrasions in the face and neck can occur during CPR. Raven *et al* reported 64% laryngeal and tracheal mucosal injury, 14% strap muscles hemorrhage, and 4% cutaneous injury of the neck in 50 cadavers who had been resuscitated (9). Yoshiko Hashimoto *et al* have also reported post-CPR neck hemorrhages with hyoid bone and thyroid cartilage fractures (24).

Among our cardiac causes of death, 5 cases had submucosal hemorrhage. In addition to hemorrhages caused by congestion, the possibility of mucosal injuries during intubation should be considered. Hemorrhages in the lateral and anterior sides of the neck in cardiopulmonary causes of death may be due to the manipulation during CPR. Moreover, the most frequent posterior neck hemorrhages were found in cardiac causes of death. Intense lividity can be associated with small hemorrhages in the skin (14) when decompositional changes occur in livid skin there is intravascular hemolysis and staining of the surrounding tissues will mimic bruising (25). Considering the presence of lividity in the

back of these cases, the high prevalence of hemorrhages could be associated to postmortem gravitational leakage from distended blood vessels due to cardiac dysfunction leading to intense blood congestion in the posterior side of the neck and formation of pseudo-bruises or hemorrhagic lividity (26, 27). However, this theory does not justify other cardiopulmonary causes of death with hemorrhages in lateral and anterior sides of the neck. It seems that the death condition and specifically the cause of death are contributing factors in producing these hemorrhages.

Maxeiner studied 134 deaths occurred during fire. He found that specific examination of the laryngeal area revealed congestion-induced extravasations at various points, as well as petechial hemorrhage in the mucous membrane (12). Yoshiaki Hashimoto *et al*. reported 23 cases of intramuscular bleeding of the tongue in 69 burned bodies which the frequency of intramuscular bleeding was higher in victims displaying low CO-Hb concentrations. Lack of skin elasticity following burns, particularly in the neck, might act in a similar manner to neck compression and cause intramuscular hemorrhage (13).

Our study shows that CO poisoning, drug overdose and burning are other causes of death associated with neck hemorrhage. Most of the hemorrhages in these cases have been found to be intramuscular or submucosal. As the CO poisoned cases had no sign of burn and the drug abusers had no sign of trauma, neck hemorrhages may be due to severe contractions in neck musculature resulting from convulsion during agony.

This research was done on Iranian cadavers in Legal Medicine Organization. Legal Medicine Organization of Iran with more than 1.5 million clinical forensic referrals and 50,000 autopsies per year is an appropriate field for such research and training (28-30) however as our cases were selected within the files referred to highly specialized centers such as the Tehran

Medical Commission, so the frequency of causes of deaths might not conform to the actual frequency in the society.

The limitation in this study was the inadequacy of information in some files which led to the exclusion of the respective cases from the study. The files included in this study were selected among cases referred to highly specialized centers such as the Tehran Medical Commission, so the frequency of causes of deaths might not conform to the actual frequency in the society.

5. Conclusion:

Soft tissue hemorrhage of the neck occurs in some known causes of death like multiple traumas or asphyxial death, but it may happen in other causes of death without any direct trauma or neck compression. More studies on atypical causes of death with neck hemorrhage are required to prevent ambiguous judgments about cause of neck hemorrhage in suspected cases.

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References

1. Samarasekera A, Cooke C. The pathology of hanging death in Western Australia. *Pathology*. 1996;28:334-8.
2. Luke JL. Asphyxial death by hanging in New York city, 1964-1965. *J Forensic Sci*. 1967;12:359-69.
3. James R, Silcocks P. Suicidal hanging in Cardiff-a 15-year retrospective study. *Forensic Sci Int*. 1992;56:167-175.
4. Maxeiner H, Bockholdt B. Homicidal and suicidal ligature strangulation: a comparison of the postmortem findings. *Forensic Sci Int*. 2003;137:60-6.
5. Ubelaker DH. Hyoid fracture and strangulation. *J Forensic Sci*. 1992;37:1216-22.
6. Azmak D. Asphyxial death: a retrospective study and review of literature. *Am J Forensic Med Pathol*. 2006;27:134-44.
7. Prinsloo J, Gordon I. Post-mortem dissection artifacts of the neck; their differentiation from ante-mortem bruises. *S Afr Med J*. 1951;25:358-61.
8. Lach H, Püschel K, Schulz F. Intramuscular bleeding in deaths from an internal cause: forensically significant differential diagnosis between external trauma and hemorrhages occurring during agony. *Arch Kriminol*. 2005;216:97-107.
9. Raven KP, Reay DT, Harruff RC. Artifactual injuries of the larynx produced by resuscitative intubation. *Am J Forensic Med Pathol*. 1999;20:31-6.
10. Lunetta P, Penttila A, Sajantila A. Circumstances and macropathologic findings in 1590 consecutive cases of bodies found in water. *Am J Forensic Med Pathol*. 2002;23:371-76.
11. Carter N, Ali F, Green MA. Problems in the interpretation of hemorrhage into neck musculature in cases of drowning. *Am J Forensic Med Pathol*. 1998;19:223-25.
12. Maxeiner H. Hemorrhage of the head and neck in death by burning. *Z Rechtsmed*. 1988;101:61-80.
13. Hashimoto Y, Moriya F, Nakanishi A. Intramuscular bleeding of the tongue in the victims of house fire. *Leg Med (Tokyo)*. 2003;5:328-31.
14. Pollanen MS, Perera SD, Clutterbuck DJ. Hemorrhagic Lividity of the Neck: Controlled Induction of Postmortem Hypostatic Hemorrhages. *Am J Forensic Med Pathol*. 2009;30:322-26
15. Shkrum MJ, Ramsay DA. *Forensic Pathology of Trauma*. 1st ed. Totowa, New Jersey: Humana Press; 2007.
16. DiMaio VJ, DiMaio D. *Forensic Pathology*. 2nd ed. New York: CRC Press; 2001.
17. Rajs J, Tiblin I. Histologic appearance of fractured thyroid cartilage and surrounding tissue. *Forensic sciences Int*. 2000;114:155-66.
18. Saukko P, Knight B. *Knight's Forensic Pathology*. 3rd ed. London; Arnold; 2004.
19. Maxeiner H. Mucosal hemorrhage of the larynx in strangulation and other causes of death. *Beitr Gerichtl Med*. 1989;47:429-35.
20. Maxeiner H. Hidden laryngeal injuries in homicidal strangulation: how to detect and

- interpret these findings. *J Forensic Sci.* 1998;43:784-91.
21. Alexander RT, Jentzen JM. Neck and scleral hemorrhage in drowning. *J Forensic Sci.* 2011 ;56:522-5
 22. Sigrist T, Schulz F, Koops E. Confusing muscular hemorrhage in a drowned cadaver. A contribution to differentiation between vital and postmortem changes. *Arch Kriminol.* 1994;193:90-6.
 23. Püschel K, Schulz F, Darmann I, Tsokos M. Macromorphology and histology of intramuscular hemorrhages in cases of drowning. *Int J Legal Med.* 1999;112:101-6.
 24. Hashimoto Y, Moriya F, Furumiya J. Forensic aspects of complications resulting from cardiopulmonary resuscitation. *Leg Med (Tokyo).* 2007;9:94-9.
 25. Pollanen M. Forensic pathology and the miscarriage of justice *Forensic Sci Med Pathol*, Springer Science+Business Media, LLC 2011
 26. Vanezis P. Interpreting bruises at necropsy. *J Clin Pathol.* 2001;54:348–55.
 27. Burke MP, Olumbe AK, Opeskin K. Postmortem extravasation of blood potentially simulating antemortem bruising. *Am J Forensic Med Pathol* 1998;19:46–9.
 28. Sheikhazadi A, Kiani M, Taghaddosinejad F. Violence in forensic medicine practice: a survey of legal medicine practitioners' views. *Am J Forensic Med Pathol.* 2009; 30: 238–241.
 29. Sheikhazadi A, Kiani M, Ghadyani M. Electrocutation-Related Mortality A Survey of 295 Deaths in Tehran, Iran Between 2002 and 2006. *Am J Forensic Med Pathol.* 2009; 31:42-45.
 30. Sheikhazadi A, Sadr SS, Ghadyani MH. Study of the normal internal organ weights in Tehran's population. *J Forensic Leg Med.* 2010;17:78-83.