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PAPER

PATHOLOGY/BIOLOGY

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Laryngeal Choking on Food and Acute Ethanol Intoxication in Adults—An Autopsy Study*

ABSTRACT: The retrospective autopsy study included 98 adults who died because of laryngeal choking on a bolus of food: 67 men and 31 women ($\chi^2 = 6.843$, $p < 0.01$), average age 58.61 ± 15.87 years (range 26–92 years). Most of the subjects had poor dentition ($\chi^2 = 34.327$, $p < 0.01$). Twenty individuals died in medical institutions, and 78 were nonhospitalized individuals. More than a third of the nonhospitalized individuals were under the influence of ethanol at the moment of death: average blood concentration 8.3 g/dL (SD = 11.0), ranged from 5.0 to 36.0. Nonhospitalized persons were at the moment of event more often under influence of ethanol than the subjects in control group ($\chi^2 = 38.874$, $p < 0.01$), and at the same time significantly more intoxicated ($z = -7.126$, $p < 0.01$). Our study pointed out that poor dentition and impairment of the swallowing reflex, as a consequence of ethanol intoxication in individuals without mental disorders, were the most important risk factors for bolus death.

KEYWORDS: forensic science, forensic pathology, choking on food, acute ethanol intoxication, bolus death, asphyxia

Choking is the blockage of the internal airways, usually between the pharynx and the bifurcation of the trachea. Causes of choking include metallic, plastic or other foreign bodies, food material (aspiration of vomit, or bolus of food), as well as acute obstructive lesions (edema of glottis or larynx because of acute hypersensitivity, irritant vapors, inhalation of hot gas or infections) (1). Long-lasting benign neoformations (laryngeal cysts, polyps, lingual tonsil, hemangiomas, etc.) or other conditions could compromise the upper respiratory tract, causing choking (2–5).

The phases of acute fatal airway obstruction are penetration of the object into the airway, obstruction of the airway, and failure to expel once the obstruction has occurred (6). Choking and obstruction of the trachea or main bronchi by aspiration of a foreign body is a common cause of accidental death in children aged from 1 to 3 years, i.e., "crèche coronary" (6–10).

In adult cases, the most common cause of laryngeal obstruction is by a bolus of food, i.e., "café coronary." The term was invented by Haugen in 1963 for sudden and unexpected death occurring during a meal because of the accidental occlusion of the airway by a bolus of food (11). The most common victims were well-nourished businessmen, who died suddenly during a meal, with no signs of respiratory distress or asphyxia (1), with predisposing factors, such as decreased protective airway reflex resulting from aging, poor dentition with a tendency to swallow food whole, ethanol consumption, and ingestion of other depressants of the central nervous system, impairing the gag reflex (6,12,13).

Homicidal deaths by choking are relatively uncommon, and often in conjunction with gagging (13). Suicidal deaths by choking are possible (14,15). Choking on food among adults is virtually always accidental. Sometimes in adults, the foreign body which makes the laryngeal obstruction as a bolus of food, can be a wine cork, a denture, or even a live fish (16,17).

The aim of our study was primarily to determine the significance of acute ethanol intoxication in cases of fatal laryngeal choking on a bolus of food in our social conditions, particularly in individuals without mental disorders.

Materials and Methods

The retrospective autopsy study for a 16-year period was performed. The cases involved in the study were adults, whose forensic autopsy established the laryngeal choking on a bolus of food as the cause of death: in all the cases, with masticated or semi-masticated pieces of food, the bolus was found in the larynx, completely occluding the laryngeal lumen. All the deceased died at the scene, with no outliving period. The autopsy reports, police records, and heteroanamnestic data for each deceased were analyzed and evaluated with regard to gender, age, circumstances of death, and consumption of ethanol at the moment of death. To determine the frequency and blood ethanol concentration in cases of bolus death, we compared them to a control group. We singled out all the forensic cases for a 2-year period in which ethanol was analyzed for in postmortem blood. These cases included suicides, homicides, accidents (traffic, labor, domestic, etc.), as well as unexpected sudden deaths from natural causes; all of these deceased were without an outliving period after injury. That way we established the

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expected frequency of ethanol influenced persons and ethanol concentration as well, in a population of forensic pathology interest, in our specific social conditions. Blood for analyses was obtained from the femoral vein, during autopsy, which was performed 12–36 h after death. We considered a person to be under the effects of ethanol, if the blood ethanol concentration was 5.0 g/dL or more. This analysis was conducted by headspace gas chromatography.

The obtained data were statistically analyzed using Pearson's chi-square test, the Student's *t*-test, and the Mann–Whitney rank sum test when necessary (when data were nonparametric which were tested with the Kolmogorov-Smirnov test for normal distribution), for estimating differences. A p-value <0.05 was considered significant, and <0.01 highly significant.

Results

The sample included 98 deceased: 67 men and 31 women, of average age 59.2 ± 15.7 years (range from 26 to 92 years). The sample distribution in regard to gender and age is shown in Table 1.

Twenty of 98 persons died in medical institutions: 13 men and seven women. Fifteen of them died in psychiatric facilities: most of them—nine, were ill with schizophrenia, four with senile dementia, and two with Alzheimer's disease. Five of 20 died in medical institutions because of laryngeal choking on a bolus of food, during treatment after brain injury: all five suffered from psycho-organic syndrome—three of them had subarachnoid hemorrhage owing to a ruptured cerebral aneurysm, and two of them had severe traumatic brain injury.

In our observed sample, 78 of 98 subjects were nonhospitalized individuals: 54 men and 24 women, average age 59.2 ± 15.7 years. Most of them died in private homes—49 deceased, 24 of them died in public areas, and seven in restaurants and bars. More than a third of them (33 of 78—30 men and three women), at the moment of choking by bolus of food, were under the influence of ethanol (blood ethanol concentration was more than 5.0 g/dL): average blood ethanol concentration was 8.3 g/dL (SD = 11.0) and ranged from 5.0 to 36.0 g/dL (Fig. 1). Twenty of them were chronic alcohol abusers (autopsy revealed changes in internal organs, as a consequence of chronic alcoholism).

According to the police reports and heteroanamnestic data obtained from relatives and neighbors, 20 of the 78 nonhospitalized deceased, had been treated at some point in their life for some kind of mental disorders: eight for psychosis, nine for various types of anxiety, one for psycho-organic syndrome, and two suffered from intellectual disability. Five of the 20 were under the effects of ethanol at the moment of choking on a bolus of food. For 53 of 78 of them, there was no data of any kind on mental disorders during life. For five of the deceased in this part of our sample, data on mental disorders could not be obtained because they were homeless people: two of them were under the effects of ethanol at the moment of death.

The control group included a total of 1470 cases, 1082 men and 388 women, average age 55.1 ± 19.0 years. At the moment of death, 226 of them were under the influence of ethanol, with blood ethanol concentration over 5.0 g/dL: average blood ethanol concentration was 6.1 g/dL (SD = 4.0) and ranged from 5.0 to 66.0 g/dL (Fig. 1).

The sample distribution in regard to dentition is presented in Table 2.

Discussion

The suddenness and rapidity of death suggested an acute heart attack, thus the name café coronary (18). Sometimes, the bolus of food was firmly lodged in the lumen of the larynx, and it could be accepted that the cause of death was attributed to the simple obstruction of upper airways by a bolus of food. Pieces of food may be found in both infra- and supraglottic areas, and on occasion may have impacted inside the esophagus and caused airway obstruction because of an external compression of the trachea, especially in children (19). Nevertheless, some deaths occurred because of choking even though the airway was not completely occluded (13). In these cases of incomplete occlusion of the larynx, there is a possibility of a bolus getting from the stomach to the larynx postmortally, and therefore not actually being a real bolus. That is why our study included only the cases of laryngeal occlusion by a bolus of food. A litmus test of the bolus to determine its acidity will ascertain whether it originated from the mouth or consisted of vomitus from the stomach (18). Some authors suggested that death is caused by the stimulation of the laryngeal or pharyngeal mucosa by a bolus, and overactivity of the parasympathetic nervous system—the vasovagal reflex or reflex cardiac inhibition (1). In some cases, laryngospasm is suggested as the cause of death (13), as well as bronchospasm (20). With the postmortem use of modern imaging techniques like multislice computed tomography and magnetic resonance imaging, the foreign bodies, such as a bolus of food, could be diagnosed without an autopsy (21).

In our sample, the gender male–female ratio was 2:1 ($\chi^2 = 6.843$, $p < 0.01$). In separate observed hospitalized and nonhospitalized persons, similar distribution was obtained. Other studies pointed out an almost equal number of men and women (12,22,23). Our study showed that the majority of cases were people around 60 years old, which is also pointed out by other authors (12,23).

One of the major risk factors for bolus deaths are poor dentition and being edentulous (12,22). In our sample, out of 98 subjects, the significant number—almost two-thirds, had poor dentition (significant number of teeth missing,), or were edentulous ($\chi^2 = 34.327$, $p = 0.00$). However, there was no statistically significant difference in dentition, neither between the group of hospitalized and nonhospitalized ($\chi^2 = 1.016$, df = 3, $p > 0.05$), nor between the group of

TABLE 1—*Sample distribution in regard to place of death, gender, and age.*

		Age (years)							
	Gender	< 30	31–40	41–50	51–60	61–70	71–80	> 80	Total
Nonhospitalized	Male	4	7	9	13	8	11	2	78
	Female	0	0	3	5	4	8	4	
Hospitalized	Male	1	3	3	1	4	1	0	20
	Female	0	0	2	0	2	2	1	
Total	Male	5	10	12	14	12	12	2	98
	Female	0	0	5	5	6	10	5	

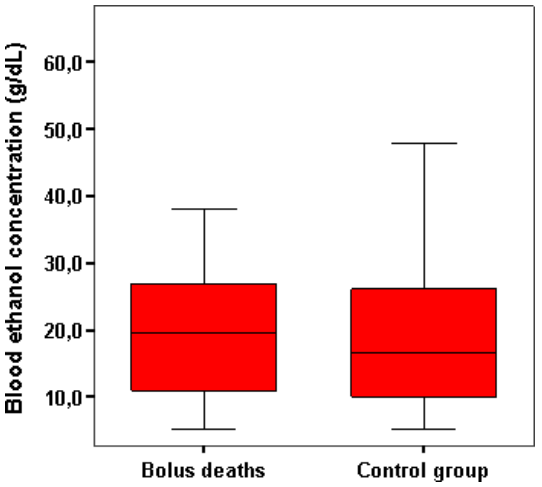

FIG. 1—*Box and whisker plots representing blood ethanol concentrations in subjects under the effects of ethanol in the nonhospitalized laryngeal bolus of food death group and control group. The lower boundary of the box indicates 25th percentile, a line within the box marks median, and the upper boundary of the box indicates 75th percentile. Error bars above and below the box indicate the 90th and 10th percentiles.*

TABLE 2—*The sample distribution in regard to dentition.*

	Teeth Status				
	Intact Dentition	Few Missing	Significant Number Missing	Edentulous	Total
Nonhospitalized under the effects of ethanol	4	14	9	6	33
Nonhospitalized without ethanol	3	10	19	13	45
Hospitalized	2	4	9	5	20
Total	9	28	37	24	98

all sober subjects, and the group of subjects under the effects of ethanol ($\chi^2 = 6.066$, df = 3, $p > 0.05$). In other words, the dentition was almost equally poor in all of our observed subjects, which implied that the poor state of dentition was the main risk factor for bolus death.

The second important risk factor for bolus death is an impairment of the swallowing reflex, which could be a consequence of psychiatric or neurologic disease, or a consequence of the side effects of various psychotropic drugs and ethanol intoxication. In the elderly, it is likely that a combination of different factors could contribute to the fatal laryngeal choking on a bolus of food (12).

It is rare for neurologically intact adults to choke to death on a bolus of food which makes a complete occlusion of the larynx. Senile persons in retirement homes and mentally retarded children are also vulnerable to bolus death (1). People could choke on food because of a neurologic disease that impairs the swallowing mechanism (strokes, Parkinson's disease, cerebrovascular disease, multiple sclerosis, etc.), or psychiatric disorders that interfere with proper ingestion (schizophrenia, obsessive-compulsive disorder, mental impairment, polyphagic syndrome, etc.). Experimental studies showed that various psychotropic medicines (antipsychotics, antidepressants, sedatives) could influence the swallowing reflex on the level of the lateral solitary complex of the medulla oblongata activity. The suppression of this reflex is achieved through modification of the actions of neurotransmitters—serotonin, noradrenaline, and dopamine (24–28).

One-fifth of all cases in our sample died in medical institutions, and 15 of them in psychiatric facilities: most of them, nine, were ill with schizophrenia. Some authors point out that persons ill with schizophrenia are, among all patients with mental disorders, the most vulnerable for bolus deaths (29). It seems that in patients who died from laryngeal obstruction by a bolus of food in psychiatric facilities, ravenous eating and swallowing of semi-masticated food are more important factors than some organic diseases of the central nervous system that influence the swallow reflex.

The majority of our sample, 80%, consisted of nonhospitalized deceased. The most uncommon places of death in these cases were restaurants and bars: only seven of 78. On the other hand, the most common places were private homes, as was also shown by other studies (22,23). Many of them died in public areas, such as parks, streets, or public transportation stations—places near the fast food restaurants.

Other authors pointed out that in persons who died from laryngeal choking on a bolus of food, a medium or high blood ethanol concentration almost always existed (20). This state increases the possibility of impaired coordination or reduction of the swallowing reflex, probably as a consequence of diminished sensitivity of the pharyngeal mucosa, and ethanol effects on the central nervous system as well. On the other hand, higher blood ethanol concentration also disturbs counterbalance to vagal reflexes (20).

Among nonhospitalized persons in our sample, more than one-third (33 of 78) were under the influence of ethanol at the moment of laryngeal choking on a bolus of food, and most of them were chronic alcohol abusers. Other studies showed similar results (23). For 53 of the nonhospitalized deceased, the heteroanamnestic data indicated clearly that they were not treated for any kind of mental disorder during life: almost half of those—26 subjects—were under the effect of ethanol at the moment of death.

As standard deviations of established average blood ethanol concentration in our sample were higher than mean values, in nonhospitalized subjects, as well as in the control group, we could not use the Student's *t*-test for comparing. But more sophisticated statistical methods pointed out the significant differences: the subjects in the analyzed group of nonhospitalized persons who died from laryngeal choking on a bolus of food were at the moment of the event, more often under the influence of ethanol than the subjects in the control group ($\chi^2 = 38.874$, $p < 0.01$), and at the same time they were significantly more intoxicated ($z = -7.126$, $p < 0.01$). These two groups were similar in gender and age distribution ($t = 1.882$, $p > 0.05$). These results emphasized ethanol intoxication as one of the most important risk factors for laryngeal choking on a bolus of food among people without mental disorders.

Our study indicated that poor dentition is the main risk factor for bolus death: it seems that poor dentition is *conditio sine qua non* for laryngeal choking on food. Impairment of the swallowing reflex is the other risk factor and it could be a consequence of psychiatric or neurologic disease or, among people without mental disorders, ethanol intoxication.

In our observed and analyzed sample, bolus deaths were typical among men about 60 years old, who died because of choking on a bolus of food at private homes, or in public places near fast food restaurants. These persons were more often under the influence of ethanol and with higher blood ethanol concentration, than would be expected in our social conditions, where ethanol abuse is, in general, highly tolerated. Our study pointed out that elevated blood ethanol concentration is one of the most important risk factors for

fatal laryngeal choking on a bolus of food among people without mental disorders.

References

1. Knight B. Forensic pathology, 3rd edn. London: Arnold, 2004.
2. Porzionato A, Macchi V, Rodriguez D, De Caro R. Airway obstruction by laryngeal masses in sudden and homicidal deaths. Forensic Sci Int 2007;171(1):e15–20.
3. Kawakami M, Hayashi I, Yoshimura K, Ichihara K, Nishikawa S, Ichihara T. Adult giant hemangioma of the larynx: a case report. Auris Nasus Larynx 2006;33:479–82.
4. Byard RW, Williams D, James RA, Gilbert JD. Diagnostic issues in unusual asphyxial deaths. J Clin Forensic Med 2001;8:214–7.
5. Wankhede AG. A throttled hemophilic who died due to choking. Forensic Sci Int 2007;171(1):e21–3.
6. Schrum MJ, Ramsey DA. Forensic pathology of trauma. Totowa, NJ: Humana Press, 2007.
7. Oguz F, Citak A, Unuvar E, Sidal M. Airway foreign bodies in childhood. Int J Pediatr Otorhinolaryngol 2000;52:11–6.
8. Tomaske M, Gerber A, Stocker S, Weiss M. Tracheobronchial foreign body aspiration in children—diagnostic value of symptoms and signs. Swiss Med Wkly 2006;136:533–8.
9. Yadav S, Singh J, Aggarwal N, Goel A. Airway foreign bodies in children: experience of 132 cases. Singapore Med J 2007;48:850–3.
10. Bloom D, Christenson T, Manning S, Eksteen EC, Perkins JA, Inglis AF, et al. Plastic laryngeal foreign bodies in children: a diagnostic challenge. Int J Pediatr Otorhynolaryngol 2005;69:657–62.
11. Haugen RK. The café coronary. Sudden deaths in restaurants. JAMA 1963;186:142–3.
12. Wick R, Gilbert JD, Byard RW. Café coronary syndrome—fatal choking on food: an autopsy approach. J Clinic Forensic Med 2006;13:135–8.
13. DiMaio VJ, DiMaio D. Forensic pathology, 2nd edn. Boca Raton, FL: CRC Press, 2001.
14. Saint-Martin P, Bouyssy M, O'Byrne P. An unusual case of suicidal asphyxia by smothering. J Clinic Forensic Med 2006;14:39–41.
15. Sauvageau A, Yesovitch R. Choking on toilet paper. An unusual case of suicide and a review of the literature on suicide by smothering, strangulation, and choking. Am J Forensic Med Pathol 2006;27:173–4.
16. Pinheiro J, Cordeiro C, Vieira DN. Choking death on a live fish (Dicologoglossa cuneata). Am J Forensic Med Pathol 2003;24:177–8.
17. Deidiker R. Return of the killer fish: accidental choking death on a bluegill (Lepomis macrochirus). Am J Forensic Med Pathol 2002;23:197–8.
18. Spitz WU. Spitz and Fisher's medicolegal investigation of death: guidelines for the application of pathology to crime investigation, 4th edn. Springfield, IL: Charles C Thomas Publisher, 2006.
19. Byard RW. Mechanisms of unexpected death in infants and young children following foreign body ingestion. J Forensic Sci 1996;41:438–41.
20. Brinkmann B, Madea B. Handbuch gerichtliche Medizin. Berlin Heidelberg New York: Springer-Verlag, 2004.
21. Oesterhelweg L, Bolliger SA, Thali MJ, Ross S. Virtopsy—postmortem imaging of laryngeal foreign bodies. Arch Pathol Lab Med 2009;133: 806–10.
22. Dolkas L, Stanley C, Smith AM, Vilke GM. Deaths associated with choking in San Diego County. J Forensic Sci 2007;52:176–9.
23. Berzlanovich AM, Fazeny-Dörner B, Waldhoer T, Fasching P, Keil W. Foreign body asphyxia. A preventable cause of death in the elderly. Am J Prev Med 2005;28:65–9.
24. Kessler JP, Jean A. Inhibition of the swallowing reflex by local application of serotonergic agents into the nucleus of the solitary tract. Eur J Pharmacol 1985;118(2):77–85.
25. Kessler JP, Jean A. Effect of catecholamines on the swallowing reflex after pressure microinjections into the lateral solitary complex of the medulla oblongata. Brain Res 1986;386(1-2):69–77.
26. Kessler JP, Jean A. Inhibitory influence of monoamines and brainstem monoaminergic regions on the medullary swallowing reflex. Neurosci Lett 1986;65(1):41–6.
27. Kurozumi C, Yamagata R, Himi N, Koga T. Emetic stimulation inhibits the swallowing reflex in decerebrate rats. Auton Neurosci 2008;140(2): 24–9.
28. Harada H, Takakusaki K, Kita S, Matsuda M, Nonaka S, Sakamoto T. Effects of injecting GABAergic agents into the medullary reticular formation upon swallowing induced by the superior laryngeal nerve stimulation in decerebrate cats. Neurosci Res 2005;51(4):395–404.
29. Ruschena D, Mullen PE, Palmer S, Burgess P, Cordner SM, Drummer OH, et al. Choking deaths: the role of antipsychotic medication. Br J Psychiatry 2003;183:446–50.

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