Tongue position and its relation to the cause of death and sequential stages of body decomposition observed during 608 forensic post-mortems

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Abstract

The purpose of this study was to document tongue position and its relation to the cause of death and sequential stages of body decomposition, as observed during the routine forensic pathological examination of bodies. The sample of 608 included all bodies examined by the first and third authors during the period April 2016 to September 2016. Tongue position was recorded in all cases where position of the tongue could be visually determined. The condition of the body was recorded as follows: fresh flaccid, fresh with rigor mortis, early decomposition, and advanced decomposition. The cause of death was recorded where known. The results showed that 86% of all bodies examined did not show a protruded tongue and that 92.8% of the bodies were in a state of fresh rigor mortis. The study also showed that tongue protrusion was more prevalent in certain causes of death, namely, hanging, burning, and drowning, but was never absolute. The authors believe that due to the low numbers of bodies presenting with protruded tongues, this phenomenon has previously been overlooked, the significance thereof underestimated, and the pathophysiology and pathomorphology never fully investigated.

Keywords: Forensic pathology; Forensic odontology; Cause of death; Tongue protrusion; sequential decomposition

Introduction

In forensic pathology reviews, very little importance is given to the position of the tongue in forensic pathology investigations [1]. Tongue protrusion is a common but non-specific finding in the forensic examination of bodies [2,3,4]. According to Madea [5], the tongue is usually described with the internal organs, but it should be examined in situ as evisceration may conceal evidence of injury. There is general consensus that victims of hanging may present with protruded tongues [6] and that cases of advanced putrefaction with gas formation may also present with protruded tongues [7]. Bernitz et al. [8] published an article in which tongue protrusion was purported to indicate a vital reaction during burning. Although Hejna et al. [9] described the research as “gold nuggets of observational research,” other authors have been critical of the results and conclusions of the research [10, 11]. Very little has been published on the position of the tongue in general forensic pathological examinations as experimental models would be difficult and unethical to simulate. We cannot experimentally burn, drown, or hang individuals in an effort to better understand the processes that take place during these episodes. We therefore have to use observational

research to postulate the possible pathophysiological (vital) and pathomorphological (non-vital) processes.

Aim

The aim of this study was to document tongue position and its relation to the cause of death and sequential stages of body decomposition as observed during the routine forensic pathological examination of bodies.

Materials and methods

The study included all bodies examined by the first and third authors at a medicolegal mortuary during the period April 2016 to September 2016. The total sample size included 608 bodies including males and females of all ages (see Tables 1 and 2). The racial spread was indicative of the demographics of the area served by the mortuary (see Table 3). Tongue position was recorded in all cases where position of the tongue could be visually determined (see Table 4). A protruded tongue was defined as one which extended beyond the dental arches with the teeth separated. A non-protruded tongue was defined as one positioned within the occluded dental arches. The first and third authors were calibrated regarding the assessment of the state of body decomposition. The condition of the body was recorded as follows: fresh flaccid, fresh with rigor mortis, early decomposition, and advanced decomposition. Exclusion criteria included cases where the position of the tongue could not be determined and cases where bodies presented with intubation tubes. The cause of death was recorded where known. Pearson's chi-square test was performed to test whether there existed associations between tongue position and state of the body and cause of death respectively. This test compares the observed frequencies (the number of cases in each cell of the cross tabulation of two categorical variables) to the frequencies one would expect to get should the cases be randomly distributed to the cells of the cross tabulation of the two variables. The death register (DR) number was used for reference purposes only, as each body was given a research number. The death register number (DR) was used only by the authors and strict anonymity of all bodies was assured. The research project was approved by the ethics committee of the Faculty of Health Sciences and is in accordance with the 1964 Declaration of Helsinki. For this type of study, formal consent is not required.

Table 1 Cases according to gender

Gender	Number of cases	Percentage of cases
Male	502	82.6
Female	104	17.1
Unknown	2	0.3
Total	608	100.0

Table 2 Cases according to age groups

Age group	Number of cases	Percentage of cases
Younger than 18 years	71	11.7
18–59 years	473	77.8
60 years and older	48	7.9
Unknown	16	2.6
Total	608	100.0

Table 3 Cases according to race

Race group	Number of cases	Percentage of cases
Black	437	71.9
Colored	20	3.3
White	129	21.2
Unknown	22	3.6
Total	608	100.0

Table 4 Tongue position

Position of tongue	Number of cases	Percentage of cases
Non-protruded	523	86.0
Protruded	85	14.0
Total	608	100

Results

Pearson's chi-square test indicated significant associations between tongue position and state of the body and also between tongue position and cause of death (p value < 0.001). The observed and expected values in the two cross tabulations as reported in Tables 5 and 6 were interpreted to determine which cell(s) contributed significantly to the overall chi-square statistics. Specifically, it was noted that when the cause of death was hanging or burns, the observed number of cases with protruded tongues was significantly more than expected (see Table 6).

Table 5 State of the body and tongue position. Italicized text represents state of bodies where observed tongue protrusion values were > 25%

	Tongue position						
State of the body	**Non-protruded**			**Protruded**			
	Observed	**Expected**	**%**	**Observed**	**Expected**	**%**	**Total**
Fresh flaccid	11	11.2	84.6	2	1.8	15.4	13
Fresh with rigor mortis	494	485.2	87.6	70	78.8	12.4	564
Early decomposition	*16*	*18.9*	*72.7*	*6*	*3.1*	*27.3*	*22*
Advanced decomposition	*2*	*7.7*	*22.2*	*7*	*1.3*	*77.8*	*9*
Total	523		86.0	85		14.0	608

Table 6 Cause of death and tongue position. Italicized text represents the cause of death where observed tongue protrusion values were > 25%

Cause of death	Tongue position						
	Non-protruded			Protruded			
	Observed	Expected	%	Observed	Expected	%	Total
Transport related accidents	163	152.3	92.1	14	24.7	7.9	177
Gunshot wounds	84	77.4	93.3	6	12.6	6.7	90
Sudden death	69	60.2	98.6	1	9.8	1.4	70
Stabbing/assault	64	60.2	91.4	6	9.8	8.6	70
Hanging	*15*	*40.4*	*31.9*	*32*	*6.6*	*68.1*	*47*
Overdose/poisoning/gassing	31	28.4	93.9	2	4.6	6.1	33
Abortion/stillbirth/fetus	24	25.8	80.0	6	4.2	20.0	30
Burns	*12*	*18.9*	*54.5*	*10*	*3.1*	*45.5*	*22*
Drowning	*10*	*12.0*	*71.4*	*4*	*2.0*	*28.6*	*14*
Other/unspecified	51	47.3	92.7	4	7.7	7.3	55
Total	523		86.0	85		14.0	608

Discussion

General

This is the first study to document the tongue position observed in bodies during the general practice of forensic pathology. The study included the documentation of the tongue position and its relation to the cause of death and sequential stages of body decomposition. Of all bodies studied, 86% (523 out of 608) did not show a protruded tongue (see Table 4), and 92.8% (564 out of 608) of the bodies examined were in a state of fresh rigor mortis (see Table 5). The study also showed that tongue protrusion was more prevalent in certain causes of death, but was never absolute (see Table 6). The authors believe that due to the low numbers of bodies presenting with protruded tongues, this phenomenon has previously been overlooked, the significance thereof underestimated, and the pathophysiology and pathomorphology never fully investigated. This statement is demonstrated by the fact that in a PhD study, in which many cadavers were burnt, the researcher never documented the position of the tongue [12].

Cause of death and tongue protrusion

From the results in Table 5, we see that it is possible to observe the presence of a protruded tongue in virtually every reported cause of death. The numbers are however extremely low in certain categories. There are several causes of death that show relatively high percentages of tongue protrusion. In particular, it is noted that for hanging, burning, and drowning, the observed percentages of tongue protrusion were more than 25%. Pearson's χ^2 test indicated that a statistically significant association existed between the cause of death and the position of the tongue (χ^2 value = 159.993; p value = 0.0001). The data showed that for hanging, in more bodies (32 out of 47) than expected under the assumption of independence (6.6), a protruded tongue was observed. On the other hand, fewer bodies (15 out of 47) than was expected under the assumption of independence (40.4) did not exhibit protruded tongues. This is in agreement with most studies which state that tongue protrusion is commonly observed in cases of hanging [13]. In burn-related victims, 10 out of the 22 presented with

tongue protrusion. The number of burn fatalities included all cases of burning which included victims who had died after hospitalization, from first- to fourth-degree burns and all cases where the causes of death were “death by fire.” The research does however show a 45.5% prevalence of tongue protrusion in burn victims. In more cases (10 out of 22) than was expected under the assumption of independence (3.1), protruded tongues were observed. Of the cases which were not death by fire, only 1 of the 7 cases had a protruded tongue. In 4 out of the 14 cases of drowning, the presence of a protruded tongue was observed; this is more than was expected under the assumption of independence (2).

State of body and tongue protrusion

Of the bodies examined, 92.8% (564 out of 608) were in a state of fresh rigor mortis, and 12.4% (70 out of 564) of these bodies showed tongue protrusion. In this state, the muscles of mastication will be clenched and the tongue will be restricted to the oral cavity, so one will not expect the tongue to protrude should the body be burned, immersed in water, or hanged some hours after death in an attempt to obstruct justice. Thirteen out of 608 (2.1%) bodies presented as fresh flaccid. Only 2 of these 13 bodies presented with tongue protrusion. Our data shows a 27.3% (6 out of 22) occurrence of a protruded tongue in the early stages of decomposition. In advanced decomposition, 7 of the 9 bodies (77.8%) presented with a protruded tongue. These data are similar to a previously published paper which states that protruded tongues are commonly observed in decomposing bodies [6]. The increase in tongue protrusion with advancing state of decomposition can be explained by gas formation in early decomposition which would increase as decomposition advances forcing the tongue to protrude. In the stage of decomposition, autolysis will have led to the relaxation of rigor.

Postulations regarding the pathophysiology and pathomorphology of protruded tongues

The study shows that protruded tongues can be found in all causes of deaths. Although several suggestions have been made regarding the pathophysiology and pathomorphology of tongue protrusion, the exact mechanisms remain unknown. It has been suggested that tongue protrusion in decomposing bodies is caused by gas accumulation and enlargement of organs with the resulting purging of putrefactive fluid and decomposing tissue from the body orifices [5, 7]. In hanging, it is postulated that where the ligature passes above the larynx, the hyoid bone is pushed obliquely backwards, together with the base of the tongue, resting against the posterior wall of the pharynx. This leads to an obstruction of the airways. The tongue is then frequently pushed forward in the open mouth, protruding between the two dental arches [5]. In homicidal strangulation by ligature, manual strangulation, and suicidal strangulation, massive hemorrhages of the tongue could cause the tongue to protrude between the dental arches [13]. The difficulty arises when it comes to explaining cases of burning and drowning. In the case of burning, many believe that the constriction of the neck muscles is the main cause of tongue protrusion. The first and third authors in this study have observed many bodies in which tongue protrusion was present in burn cases and where the neck was minimally burned and therefore not the primary cause of the protruded tongue. Madea and Doberentz [11] commented on the paper by Bernitz [8] emphasizing the fact that the pathophysiology of tongue protrusion and swelling of the lips was a phenomenon due to vaporization (steam formation) in post-mortem burning. This pathophysiological explanation would not allow the tongue to protrude during rigor mortis and thus would only be relevant during the burning process and before rigor commences. Hashimoto et al. [14] described hemorrhage at the root of the tongue in cases of fatal burning, postulating that it may be responsible for the tongue protrusion observed. Nikolic et al. [15] postulate that the

contraction and thus shortening genioglossus muscle during heat exposure would draw the tongue forward causing protrusion. The authors state that this could occur either before or after death. Protrusion of the tongue as a result of the shortening of the genioglossus muscle could only take place before rigor mortis.

Laryngospasm has been associated with laryngeal dystonia as well as several triggers which include smoke, fumes, and drowning. Tongue protrusion has been documented in cases of dystonia [16], where the contraction of the genioglossus muscle has led to the protrusion. Laryngospasm has been reported to occur in approximately 10 to 15% of drowning victims [17]. When water enters the larynx or trachea, both conscious and unconscious persons experience laryngospasm. Common to both drowning and burning is the documented occurrence of laryngospasm. The simultaneous occurrence of laryngospasm and contraction of the genioglossus muscle could very well be the cause of the protrusion seen in both burning and drowning. Onset of rigor begins in the eyelids and jaw muscles and can begin as early as 20 min post-mortem [18]. The window of opportunity for a tongue to protrude in the early stages of post-mortem change is therefore very short. As stated in the introduction, we cannot experimentally burn, drown, or hang individuals in an effort to better understand the processes that take place during these episodes. Considering the fact that 92.8% of bodies studied were in a state of rigor mortis and thus presented with clenched jaws, the possibility of causing a tongue to protrude shortly after death is highly unlikely.

Conclusion

Relationships exist between tongue protrusion and the cause of death as well as early and advanced stages of body decomposition. The observation that most bodies seen in the mortuary were in a state of fresh rigor mortis confirms the belief that tongue position would not change during this stage of body decomposition if exposed to fire, immersed in water, or hanged. The pathophysiology and pathomorphology of tongue protrusion observed during forensic pathological examinations still remain elusive. The authors believe that the processes involved in causing the tongue to protrude are a combination of the above postulations and take place before, during, or just after the process of death.

Ethics declarations

The research project was approved by the ethics committee of the Faculty of Health Sciences, University of Pretoria and is in accordance with the 1964 Declaration of Helsinki.

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