

**Original Article****Fatal Compressive Trauma to Neck**

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**ABSTRACT**

**Objective:** A study was conducted to investigate features of death due to strangulation in Lahore and to compare them with other studies on this subject.

**Materials and methods:** 220 cases of strangulation were selected out of 2979 total medico legal autopsies conducted at Forensic Medicine department K.E.M.U Lahore during Jan, 2006-Dec, 2008. The selected cases were analyzed for different variables.

**Results:** Neck compression constituted 7.39% of total autopsies and 89.43% of total asphyxial deaths. Hanging accounted for 42.27% followed by ligature strangulation 29.09% and throttling 23.64%. All types of strangulation were prevalent in 2<sup>nd</sup>, 3<sup>rd</sup> & 4<sup>th</sup> decade of life. No case was noticed in age below 1 year. No hanging was noticed in 1<sup>st</sup> decade of life. Male had higher incidence over females in hanging in 3<sup>rd</sup> and 4<sup>th</sup> decade. Female had higher incidence in 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> decade in ligature strangulation. Male had higher incidence in 3<sup>rd</sup> and female in 4<sup>th</sup> decade in throttling. Homicidal deaths accounted for 57.27%, suicidal 30.90% and undeterminable for 11.82%. Ligature strangulation and throttling were the methods used for homicide 57.27% while hanging was used for suicide 30.97%.

Above the thyroid cartilage, the marks were 58.63% with M/F ratio 1.86:1 giving 53 (41.08%) fractures of the hyoid bone while marks at thyroid cartilage were 36.81% with M/F 1.79:1 giving (3) 3.70% hyoid bone fractures. Below thyroid cartilage 4.5% marks showed no hyoid bone fractures. Throttling showed hyoid bone fracture 69.23%, hanging 14.42% & ligature strangulation 7.81%. Ligature material used was soft in 47.62% cases and hard in 40.48%. It was used in single whirl in 57.41% cases and in multiple whirls in 42.86% cases. Ill defined marks were 40.45% and well defined were 64.09%.

In hanging knot was present on occiput in 62.50% cases and on lateral sides in 23.08% cases while 78.13% cases showed the knot on front and 21.87% cases on lateral side in ligature strangulation. Congestion was found in 85.45%, petechial hemorrhage in 81.81% and cyanosis in 75.54% cases.

**Conclusion:** Asphyxial death due to strangulation is common in our country in young age group in males. Hanging is a common method of suicide while ligature strangulation & throttling are used for homicide. The presence of compressive marks above thyroid cartilage are suggestive of death due to hanging and throttling while their presence at and below thyroid cartilage indicate ligature strangulation. This compressive trauma may or may not be associated with fracture of hyoid bone, which is a strong evidence of death due to strangulation.

**Keywords:** Hanging, Ligature strangulation, Throttling.

**INTRODUCTION**

Neck acts a conduit carrying blood, nervous impulses and air in both directions as well food to the stomach. Such a region is vulnerable to severe injuries. These injuries may include compressive trauma to neck. Compression of neck may occur in a number of ways, most commonly by ligature or manual application. In hanging compressive force is provided by the body weight of the victim. Complications of neck trauma like laryngeal edema, hemorrhage or surgical emphysema may also cause compression<sup>1</sup>. Pressure on neck may also arise from direct blows, arms locks, accidental fall onto neck, and entanglement with cords<sup>2</sup>.

When pressure is applied on neck, the effects produced depend upon the structure or structures involved

individually or collectively. However the precise events in any single case will depend upon the method used, the sites of pressure and the force with which it is applied.

Obstruction of jugular veins produces impaired return of blood from head to heart producing cyanosis, congestion and petechiae. Tension required is equal to 2 kg to occlude the veins. Obstruction of carotid arteries causes cerebral ischemia. It requires a tension of 3.5 kg for occlusion of arteries. Stimulation of baroreceptor nerve endings in the carotid sinus which lie in the internal carotid arteries just above the carotid bifurcation lead to parasympathetic and sympathetic-adrenaline stimulation. The impulses are sent to the 10<sup>th</sup> nucleus in the brain stem through glossopharyngeal

nerve and then to heart via vagus nerve. Obstruction to the respiration is also produced by the elevation of larynx and tongue closing the air way at the pharyngeal level. It is difficult to occlude the airway at laryngeal or tracheal level due to the rigidity of the strong cartilage unless extreme pressure is applied. It requires 15 kg tension. Pressure on larynx may produce fracture of hyoid bone and thyroid cartilage<sup>(2,3,4,5,6)</sup>.

Low O<sub>2</sub> level produces tissue anoxia leading to capillary damage in the form of capillary dilatation, increased permeability, stasis of blood. It produces cyanosis, congestion, petechial haemorrhage, oedema and serious effusion. Reduced blood volume and reduced flow will initiate the vicious circle of tissue anoxia. The time required to produce congestion and petechial haemorrhage in living victim is a matter of controversy but it is generally agreed that a minimum of 15 – 30 seconds is required.

### Objective

The purpose of this study is to investigate some features of death due to strangulation in Lahore and to compare them with other studies on this subject.

## MATERIALS AND METHODS

### Source of data

- All the medico legal autopsies conducted in the Department of Forensic Medicine & Toxicology KEMU Lahore during Jan 2006- Dec 2008. Autopsy reports, police documents and hospital records were perused. The selected cases were analyzed in terms of age, gender, type of compression of neck, manner of death, level of application of force in relation to thyroid cartilage, number of whirled of ligature material, presence of non specific signs of asphyxia and fracture of hyoid bone.

### Selection criteria

#### Inclusion criteria

- Cause of death is due to strangulation by compression of neck

#### Exclusion Criteria

- All deaths were excluded in which trauma on neck was present but the cause of death was other than strangulation.

## RESULTS

Total 220 cases of death due to compression of neck were selected out of 2979 medico legal autopsies conducted in the Department of Forensic Medicine & Toxicology KEMU Lahore during the 3 years study period. These cases of strangulation constituted 7.39% of total autopsies and 89.43% of total asphyxial deaths conducted during the study period.

### TYPES OF COMPRESSION OF NECK

There were 3 types of method of compression among the cases under study. The frequency of occurrence is shown in Table No.1.

**Table No. 1: Frequency distribution of various types of neck compression**

Types	No. of cases	%age
Hanging	104	47.27
Ligature strangulation	64	29.09
Throttling	52	23.64
Total	220	100.00

The ages of the cases in this group included children less than 1 year to adults above 60 years. The age group 21-30 accounted for 35.91% of cases followed by age group 31-40 years for 25.91% and age group 11-20 years for 17.27%. The age group 11-40 constituted 56.36% of all cases. No cases of strangulation were reported in the age group below 1 year. There were 144 males (65.45%) and 76 females (34.55%) cases. (Table No. 2)

**Table No. 2: Age & sex distribution of victims of fatal neck compression (n=220)**

Age in Years	Male	Female	Total	%age
<1	-	-	-	
1 – 10	2	3	5	2.27
11 – 20	23	15	38	17.27
21 – 30	59	20	79	35.91
31 – 40	36	21	57	25.91
41 – 50	9	6	15	6.82
51 – 60	10	7	17	7.73
>60	5	4	9	4.09
Total	144 (65.45%)	76 (34.55%)	220	100.00

Victims of hanging, ligature strangulation and throttling were noticed in 2<sup>nd</sup> 3<sup>rd</sup> & 4<sup>th</sup> decade of life in higher incidence. No case of fatal compression was seen in age below 1 year. No case of hanging was noticed in first decade of life.

There was higher incidence in males than females in the ratios, 2.25:1 for hanging, 2.05:1 for ligature strangulation and 1.26:1 for throttling.

In case of hanging males had highest incidence in 3<sup>rd</sup> decade and females in 2<sup>nd</sup> decade of life. In ligature strangulation males had highest incidence in 3<sup>rd</sup> decade and female in 4<sup>th</sup> decade. In throttling males had highest incidence in 3<sup>rd</sup> decade and females in 4<sup>th</sup> decade. (Table No. 3)

**Table No. 3: Age & sex distribution of various types of fatal compression of neck (n=220)**

Age (Years)	Total	Hanging (n = 104) M/F ratio 2.25:1		Ligature Strangulation (n = 64) M/F ratio 2.05:1		Throttling (n = 52) M/F ratio 1.26:1	
		M	F	M	F	M	F
<1	0	0	0	0	0	0	0
1 – 10	05	0	0	1	2	1	1
11 – 20	38	14	10	6	3	3	2
21 – 30	79	28	9	17	6	14	5
31 – 40	57	19	4	12	7	5	10
41 – 50	15	4	4	2	1	3	1
51 – 60	17	5	4	3	1	2	2
>60	9	2	1	2	1	1	2
Total	220	72	32	43	21	29	23

Legally manner of death may be natural or un-natural. In our study un-natural deaths included homicide, suicide or undeterminable deaths in which exact cause of death could not be ascertained due to natural or acquired limitations. No case of accidental compression of neck was reported during this period of study.

The distribution according to manner of death showed that homicides deaths accounted for 126 (57.27%) , suicidal death 68 (30.90%) while 26 cases (11.82%) remained un-determined due to natural or acquired limitations.

Male to female ratio was 2.15:1 for homicidal death, 2.77:1 for suicidal and 1.6:1 for un-determinable deaths . (Table No. 4)

**Table No. 4: Manner of death in fatal compression of neck (n=220)**

Age (Years)	G Total	Homicide M/F ratio 2.15:1			Suicide M/F ratio 2.77:1			Undetermined M/F ratio 1.6:1		
		M	F	Total	M	F	Total	M	F	Total
<1	0	0	0	0	00	00	0	0	0	0
1 – 10	5	2	3	5	0	00	0	0	0	0
11 – 20	38	8	6	14	5	9	14	7	3	10
21 – 30	79	36	11	47	20	06	26	4	2	6
31 – 40	57	20	14	34	16	02	18	3	2	5
41 – 50	15	8	2	10	4	01	5	0	0	0
51 – 60	17	6	3	9	5	0	5	0	3	3
>60	9	6	01	7	0	0	00	2	0	2
Total	220	86	40	126 (57.27%)	50	18	68 (30.91%)	16	10	26 (11.82%)

The manner of death in 104 cases of hanging showed 68 (68.50%) cases of suicide with M/F ratio 2.78:1. Males showed highest incidence in 3<sup>rd</sup> decade and females in 2<sup>nd</sup> decade. Homicidal hangings accounted for 9.62% and highest incidence was noticed in 3<sup>rd</sup> decade for both sexes. Male had higher incidence than female in all decades with M/F ratio 1.5:1.

Un-determined hanging accounted for 26 (25.00%). Highest incidence was seen both for males and females in 2<sup>nd</sup> decade of life. 1<sup>st</sup> & 5<sup>th</sup> decade showed no case. Male to female ratio was 1.6:1. (Table No. 5)

**Table No. 5: Manner of death in hanging (n=104)**

Age (Years)	Total	Homicide 10cases (9.62%) M/F ratio 1.5:1		Suicide 68cases (65.38%) M/F ratio 2.78:1		Undetermined 26cases (25.00%) M/F ratio 1.6:1	
		M	F	M	F	M	F
<1	0	0	0	0	0	0	0
1 – 10	0	0	0	0	0	0	0
11 – 20	24	2	1	5	6	7	3
21 – 30	37	4	2	20	5	4	2
31 – 40	23	0	0	16	2	3	2
41 – 50	8	0	0	4	4	0	0
51 – 60	9	0	0	5	1	0	3
>60	3	0	1	0	0	2	0
Total	104	6	4	50	18	16	10

In hanging 104 cases (47.27%) with M/F ratio 2.25:1 produced 15 (14.42%) fractures of hyoid bone with M/F ratio 4:1. In ligature strangulation 64 (29.09%) cases with M/F ratio 2.04:1 showed 5 (7.81%) fractures of hyoid bone with M/F ratio 1.5:1. In throttling 52 (23.64%) cases with M/F ratio 1.26:1 showed 36 (69.23%) fractures of hyoid bones with M/F ratio 2.27:1. Overall 220 cases produced 56 (25.45) fractures of hyoid bone. (Table No. 6)

**Table No. 6: Fracture of hyoid bone.**

Cause of death	No. of cases			%age	Ratio M/F	Fracture of the Hyoid bone			%age of fractures	Ratio M/F
	M	F	Total			M	F	Total		
Hanging	72	32	104	47.27	2.25:1	12	3	15	14.42	4:1
Ligature strangulation	43	21	64	29.09	2.04:1	03	02	05	7.81	1.5:1
Throttling	29	23	52	23.64	1.26:1	25	11	36	69.23	2.27:1
Total	144	76	220	100	1.89:1	40	16	56	25.45	2.5:1

Above thyroid cartilage 129 marks (58.64%) of violence or compression were found on neck, showing 53 (41.08%) hyoid bone fractures. Males showed 84 (58.33) marks with 38 (45.23%) hyoid bone fracture and females showed 45 (59.21%) marks with 15 (33.33%) hyoid bone fracture.

At level of thyroid cartilage 81 marks 36.81% were present with 3 (3.70%) hyoid bone fractures. Males showed 52 (36.11%) marks with 2 (3.84%) hyoid bone fractures while females showed 29 (38.15 %) marks with 1(3.44) fractures.

Below thyroid cartilage 10 marks (4.54%) gave no fracture of hyoid bone. Males showed 8 (5.55%) and females showed 2 (2.63%) marks.

It indicated higher incidence 129 (58.64%) above thyroid cartilage, followed by 81 (36.81%) at level and lowest 10 (4.54%) below the thyroid cartilage. Male to female ratio for above thyroid was 1.86:1, for at level 1.79:1 and for below was 4:1. (Table No. 7)

**Table No. 7: Level of compression of neck in relation to thyroid cartilage and resultant fracture of hyoid bone (n=220)**

Level	Total Cases	%age	M	%age	F	%age	M/F Ratio	Total Fractures		M	%age	F	%age	M/F Ratio
Above	129	58.64	84	58.33%	45	59.21%	1.86:1	53	41.08%	38	45.23%	15	33.3%	2.53:1
At	81	36.82	52	36.11%	29	38.15%	1.79:1	3	3.70%	2	3.84%	1	3.44%	2:1
Below	10	4.54	8	5.55%	2	2.63%	4:1	-	-	-	-	-	-	-
Total	220	100.00	144	99.99	76	99.99		56	25.45%	40	27.27	16	21.05	

In hanging 44 cases (42.30%) soft material was used and in 60 (57.69%) cases, hard material was used. 56 (53.84%) whirles were single and 48 (46.15%) multiple whirles were used. 44 (42.30%) marks were ill defined and 60 (57.69%) were well defined. In ligature strangulation, in 36 (56.25%) cases the ligature material was soft and in 28 (43.75%) hard material was used. 40(62.5%) cases showed single whirles while 24 (37.50%) showed multiple whirles. 36

(56.25%) ligature marks were ill defined and 28 (43.75%) the marks were well defined. In throttling 9 (17.30%) marks were ill defined and 43 (82.69%) marks were well defined. (Table No.8)

**Table No. 8: Marks of application of force in relation to nature of material, No. of whirls, appearance.**

		Total cases	%age	Hanging (n = 104)		Ligature Strangulation (n=64)		Throttling (n = 52)
Material	Soft	80	47.62	44	42.31%	36	56.25%	-
	Hard	68	40.68	60	57.69%	28	43.75%	-
Whirl	Single	96	57.14	56	53.84%	40	62.50%	-
	Multiple	72	42.86	48	46.15%	24	37.50%	-
Appearance of marks	Ill-defined	89	40.45	44	42.30%	36	56.25%	9 17.30%
	Well-defined	141	64.09	60	57.69%	28	43.75%	43 82.69%

Knot was present on occiput in 62.50% cases on lateral 23.08% in hanging while 78.13% cases showed knot on front and 21.88% showed on lateral side (either right or left) in ligature strangulation. Table-9

**Table No.9: Position of knot in cases of hanging and ligature strangulation**

Knot position	Hanging	Front	-	
		Occiput	65	(62.50)
		Lateral right or left	24	(23.08)
	Ligature strangulation	Front	50	(78.13)
		Occiput	-	
		Lateral right or left	14	(21.87)

Non specific signs of Asphyxia like congestion was found in 188 (85.45%) cases, petechial hemorrhage in 180 (81.81%) cases and cyanosis in 175 (75.54%) cases.

## DISCUSSION

Our study revealed that the incidence of death due to compression of neck was 7.39% of total autopsies conducted in Forensic Medicine department KEMU during the 03 years period. It constituted 89.43% of total asphyxial deaths. This figure is much higher than those reported by <sup>8</sup>1.6%, <sup>10</sup>1.75 <sup>7</sup> 1.88%,<sup>9</sup> 2.94% of all deaths & 24.53 % of all asphyxial deaths, <sup>14</sup>5% of all deaths & 82% of asphyxial deaths, <sup>15</sup>1.17%,<sup>18</sup>12.4% of asphyxial death & 5.65% of all deaths but lower than <sup>12</sup>15.7% in Edirne Turkey.

The incidence of hanging is highest 47.27% followed by ligature strangulation 29.09% and throttling 23.64%. These figures are comparable with <sup>7</sup>(hanging 57%, strangulation 21% ,throttling 18%),<sup>10</sup>(hanging 61.17%, ligature strangulation 21.19% and throttling 17.64%),<sup>8</sup>(hanging/ligature strangulation 80.7%. throttling 19.3%), <sup>13</sup>(hanging/ligature strangulation 85%, throttling 6%),<sup>18</sup>12.4 % for ligature strangulation, <sup>9</sup>(ligature strangulation 19.23%, throttling 46.15%) ,<sup>12</sup>(hanging 41.8% ligature strangulation 2.9% throttling 2.3%), <sup>14</sup>(hanging 69%).

The peak incidence for hanging, ligature strangulation and throttling is in 21-30 years of age. It was consistent with <sup>14</sup>(57% cases), <sup>15</sup>(3<sup>rd</sup> decade), <sup>14</sup>(29.55%), <sup>12</sup>(41.9 years average), <sup>17</sup>(37.36%),<sup>18</sup>( ages ranging from 1.5 to 70 years & mean age is 37.22+/-19.28 years).<sup>16</sup> Bowen has indicated a peak incidence for hanging in 50-59 years of age.<sup>17</sup>Guarner & Hanzlick quoted 31 years of age for studies in U.S.A.

Male to female ratio 1.89:1 is comparable with <sup>7</sup>(2:1) but contrary to figures given by <sup>12</sup>(3.9:1), <sup>15</sup>(3:2), <sup>18</sup>(1:1) Male to female ratio for hanging was 2.25:1, for ligature strangulation 2.05:1 and for throttling 1.26:1 showing higher incidence in males for all three types of strangulations. In hanging, males showed higher incidence (69.23%) over females (30.76%) which are consistent with <sup>12</sup>83.9% male, <sup>7</sup>2.7:1(M -73.07%/F - 26.92%).It may be attributed to the increasing economic & social burden with rising frustration of unemployment. In ligature strangulation & throttling, <sup>7</sup>58.97 males & 41.02 females have been quoted while other authors <sup>12</sup>1:3 for ligature strangulation and 1:2 for throttling & <sup>9</sup> 30.77 male % & 69.23 % females gave higher incidence in female victims..

The distribution according to manner of death showed that homicidal deaths accounted for (57.27%) which is higher than <sup>7</sup>45.05% ,much higher than <sup>12</sup>9% but lower than<sup>18</sup> 85%. Suicidal death (30.90%) is lower than <sup>7</sup>45.45% & <sup>12</sup> 47% but higher than <sup>18</sup>15%while (11.82%) remained un-determined due to natural or acquired limitations which is higher than <sup>7</sup>5.49%. <sup>12</sup>Azmak quoted 44%accidental death while no such case was reported in our study.

In hanging suicidal incidence 65.38 % is lower than <sup>7</sup>86.53%. Homicidal incidence 9.62% is higher than <sup>7</sup>(3.84%) . Incidence for undeterminable death 25% was again higher than <sup>7</sup>(9.6%) . This incidence is lower than <sup>16</sup>Bowen 95% suicidal. No case of accidental hanging was reported during this study period but <sup>16</sup>Bowen has

mentioned 5% accidental cases which are due to autoerotic cases.

The ligature marks and finger, thumb, nail marks were characteristic of all cases of death by ligature strangulation and throttling respectively. The level of constricting force over neck above thyroid cartilage was 58.64%, at level 36.81% and below thyroid cartilage 4.54%. This was comparable with other authors.<sup>9</sup> (80% above thyroid and 20% below thyroid in strangulation cases while finger and nail marks above thyroid cartilage were 58.33% and at thyroid cartilage 33.33%),<sup>7</sup> (43/52(82.52%) ligature marks above ,22/52(42.30%)& at level 6/52 (11.53%)below thyroid cartilage),<sup>14</sup> (58% above),<sup>9</sup> ( 80% above ,20% below thyroid cartilage),<sup>8</sup> ( above thyroid cartilage in hanging cases (72.7%) & below it in( 53.8%) cases of ligature strangulation) ,<sup>10</sup> (64.3 %above ,27.1% at & 8.6 % below thyroid cartilage). It indicated that the incidence of fracture of hyoid bone was related with level of constriction of neck. Above thyroid cartilage compression showed 53 (41.08%) and at level, showed 3 (3.70%) fracture of hyoid bone and is consistent with the findings of other authors.

Throttling showed 69.23%, hanging 14.42% and ligature strangulation only 7.81% fractures of hyoid bone.<sup>9</sup>Srivasta quoted 19.23 % fractures of hyoid bone (throttling 25%) and<sup>10</sup> Malik 21.2% (hanging 6.97%, ligature strangulation 30% throttling 60%)<sup>14</sup> Hussain, 22.7%,<sup>8</sup> Rehman 24.52%,<sup>12</sup>Azmak 76.7% (hanging 46.4%)<sup>15</sup>Varma 80%.<sup>7</sup>Bashir reported 21.97%

Ligature material was soft 47.62% and hard 40.48% .<sup>13</sup>Sharma reported 56% soft materiel like sari & chunni. Single whirl was used in 57.14% and multiple in 42.86%<sup>14</sup>Hussain quoted single loop 77.7% & multiple 22.3%. Appearance of mark was ill defined in 40.45% and well defined in 64.09%.

In hanging suspension point in 65 (62.50%) cases was on occiput. In 24 (23.08) was on lateral sides right or left. In ligature strangulation 50 (78.13) cases showed knot on front and 14 (21.88) cases on lateral side@@@<sup>12</sup>Azmak quoted knot on chin in 85.7% cases and on occiput 66% cases in hanging.

Cyanosis, congestion and petechial hemorrhages are classical signs of asphyxial death and could be observed in fresh bodies. Our study revealed congestion in 85.45% cases, petechial hemorrhages in 81.81% & cyanosis 5.54% which are comparable with<sup>9</sup>( congestion 73.08% , petechial hemorrhages 34.62% ),<sup>14</sup> ( cyanosis 15.20%, congestion 72.70% and petechial hemorrhages 78% ),<sup>14</sup>( congestion 74 cases,petechial hemorrhages 68 cases ,cyanosis 52 cases out of 91 cases).

It is evident from the study that the incidence of fatal compression of neck is common in our country especially hanging and this manner is the most common and favorite method used for suicide perhaps due to

easy and cheap availability of the ligature. Suicide occurs mostly in young age due to emotional instability than western countries. Males showed higher incidence certainly due to socio economic reasons. The presence of ligature mark above the thyroid cartilage is strongly suggestive of hanging while at and below the thyroid cartilage indicates death due to ligature strangulation. Throttling is common method used to kill a person due to easy accessibility and grasping of neck of the victims. The entire compressive trauma may or may not be associated with fracture of hyoid bone which is a strong evidence of death due to strangulation.

Appropriate measure to rectify socio economic disputes, familial conflicts, sexually jealousy, matter of honor, and literacy status may be helpful to reduce the homicidal & suicidal burden in near future.

The importance of scene investigation and proper postmortem external and internal examination is obvious.

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