

Death by Strangulation by Dr. Dean Hawley

Autopsy examination in cases of fatal strangulation is a procedure that has probably not changed very much in the last few decades. In fact, perhaps the best medical scientific paper ever written about examination of strangulation victims was published by Gonzales in 1933, relying on European references from the 19th century.[1] The process of strangulation, whether by hand (manual), or by ligature, results in blunt force injury of the tissues of the neck. The pattern of these injuries allows us to recognize strangulation as a mechanism, and to distinguish strangulation from other blunt injuries including hanging, traumatic blows to the neck, and artifacts of decomposition. [2, 3, 4, 5, 6, 7, 8]

It is no coincidence that the best medical evidence of strangulation is derived from post mortem examination (autopsy) of the body, but even in living survivors of strangulation assaults it may be possible to recognize a pattern of injury distinctive for strangulation. At autopsy we can exam all of the tissues of the neck, superficial and deep, and track the force vector that produced the injuries. In living people, we are left with superficial examination of the skin, and two-dimensional shadows by radiography.[9, 10] Oftentimes, even in fatal cases, there is no external evidence of injury. While patterned abrasions and contusions of the skin of the anterior neck are typical of strangulations cases, some cases have no externally evident injury whatsoever. The injuries that may occur include patterned contusions and abrasions caused by fingernails, finger touch pads, ligatures, or clothing. These injuries are then prone to change over time, with the healing process. Injuries not at all apparent on the day of death may actually become visible by the next day, as the skin begins to dry and become more transparent.

Much medical research has been published on the findings of strangulation, owing to a no-longer promoted practice by police agencies wherein “choke holds” were trained and practiced as a way for officers to subdue suspects.[11] The summary experience with choking for control of suspects -- also called the “carotid restraint hold”, “shime waza”, or “the sleeper hold” -- is that death can ensue without the intent of the officer, and without leaving external marks on the body.



In addition to the blunt force injuries of the neck, strangulation produces evidence of asphyxiation, recognized as pinpoint hemorrhages (petechiae) in the skin, conjunctiva of the eyes, and deep internal organs.[12, 13] Petechiae are non-specific findings, that can develop from any cause of asphyxia including strangulation, hanging, drowning, sudden infant death syndrome, aspiration of



gastric contents, profound depressant drug intoxication, and some natural diseases. The presence of petechiae does not prove strangulation, and the absence of petechiae does not disprove strangulation.[14] In addition to petechiae, one may also (rarely) find interstitial free air in the lung or mediastinum.[15]

Fingernail marks are superficially incised curvilinear abrasions, occurring singly or in sets. In rare cases, all four fingers will mark the skin in a single pattern.



Fingernail marks are rarely associated with the assailant's hands, but commonly associated with the victim's own fingers, as she struggles to pry the assailant's grasp off her neck. Finger touch pad contusions are caused by the assailant's grasp. The thumb generates more pressure than the other fingers, so singular thumb impression contusions are found more often than contusions showing the complete hand grasp.

Ligature abrasions follow a predictable pattern of horizontal circumscription about the neck;

distinguishable from the marks left by suicidal hanging, where a suspension point causes the ligature furrow to rise toward one ear.



The common scenario for homicidal strangulation is that the individual is found dead, often reported by the assailant, with a vague history of substance abuse or depression. There being no externally-evident injury, the body is taken for autopsy with a suspicion of drug overdose, and the injury of strangulation is not found until the neck dissection is carried out at autopsy, ordinarily at the end of the case. Therefore, photographs and trace evidence collections are not made.

The scene investigation may be useful in identifying strangulation assaults, based on blood spatter and ligatures.[16] Rarely, the latent fingerprints of the assailant may be recovered from the skin of the victim's neck.[17, 18] Of research interest, it may be possible to actually recover the assailant's skin cells from the victim's injured neck, and DNA-type the recovered cells to the suspect.[19, 20]

Ultimately, a medical opinion of strangulation as the mechanism of neck injury will be based on a complete examination of the patient's neck, either at autopsy or by radiography, to detect superficial and deep injuries fitting a pattern that supports the diagnosis. A common cited injury is fracture of the hyoid bone, actually only found in a minority (no more than one third) of all fatal strangulations.[21, 22, 23, 24, 25, 26, 27] One must keep in mind that the seriousness of the internal injury may take a few hours to be appreciated, and delayed death has been reported.[28, 29]

Autopsy examination of the neck includes complete dissection with removal of the larynx including the hyoid bone, and preferably with the tongue attached. The superficial and deep musculature must be individually examined for contusion

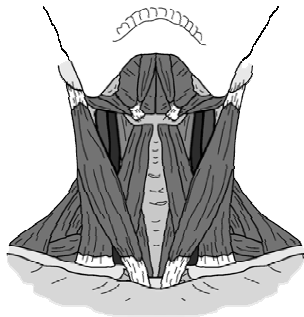
hemorrhage. The laryngeal skeleton is then exposed to examine for fracture. Finally, the cervical spine is opened and examined for injury.

There is considerable folklore about the neck injury in judicial hanging, including the notion that radical displaced fractures occur. So, common misconception allows that there will be fractures or some sort of internal neck injury in people who hang themselves. In fact, in suicidal hanging there is scarcely ever any internal evidence of neck injury at all. Suicidal hanging is usually affected with very little force. It is painless, and can be accomplished even when lying down in bed. External injury including the dramatic “rope burns” or ligature abrasion only occurs after the body has been suspended for several hours after death. If the ligature is released at the moment of death, there will be no mark in the skin. Leave the body hang suspended by the ligature for a few hours, and a very dramatic furrow and ligature abrasion will develop post-mortem.

Immediate death from hanging or strangulation can progress from one of four mechanisms:

- 1. cardiac arrhythmia may be provoked by pressure on the carotid artery nerve ganglion (carotid body reflex) causing cardiac arrest**
- 2. pressure obstruction of the carotid arteries prevents blood flow to the brain**
- 3. pressure on the jugular veins prevents venous blood return from the brain, gradually backing up blood in the brain resulting in unconsciousness, depressed respiration, and asphyxia**
- 4. pressure obstruction of the larynx cuts off air flow to the lungs, producing asphyxia**

Item number 1 must be very uncommon. The reflex cardiac arrhythmia can be reproducibly demonstrated in humans, but force must be applied over a very localized and specific anatomic area. Item number 2 must also be very uncommon in suicidal hangings, but may be more frequent in homicidal strangulations. Quite a bit of pressure is required to obstruct arterial flow in the carotids, and that amount of force would typically be associated with obvious soft tissue injury locally in the neck. Item number 3 is probably the usual route for death by suicidal hanging. Slight pressure fully or at least partially obstructs venous return in the jugular veins, gradually



causing passive congestion of blood in the vessels within the brain. This diminishes oxygen delivery to the brain, eventually resulting in loss of consciousness. The type of pressure required is slight, but prolonged. Unconsciousness probably doesn't occur for several minutes, but the overall process is completely painless. In the practice of autoerotic sexual asphyxia – a male but not female behavior of intentional ligature hanging – the asphyxia is alleged to be associated with sexual arousal.[30] In cases of suicidal hanging, eventually the individual becomes unconscious, then Item 4 takes

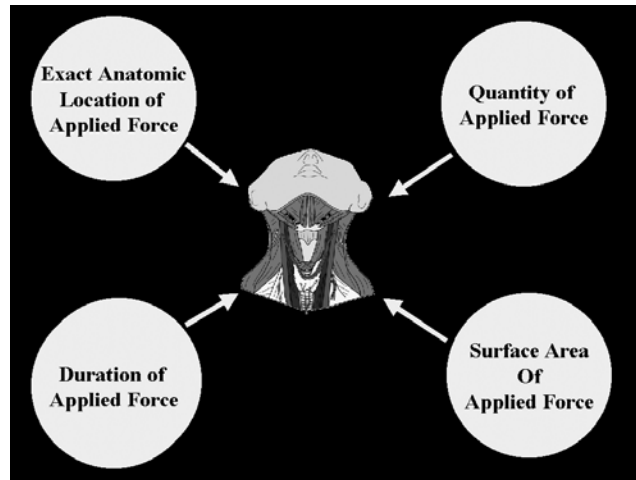
over. With the person unconscious, the full weight of the suspended part of the body falls against the ligature, creating enough pressure to restrict air flow through the trachea. Then, irreversible asphyxiation follows in just a few minutes. In strangulation cases, and some suicidal hangings where the individual is “saved” before death, there may be a prolonged period of survival with obvious brain damage, followed by death. This delay is the effect of loss of blood flow to the brain, with partial asphyxiation of the brain. A decrease in blood flow to the brain will produce a pathologic change called *anoxic encephalopathy*. Brain cells are not all equally sensitive to loss of blood flow. Some cells die soon, while others survive for days and eventually succumb to the delayed effect of oxygen deprivation.

Nerve cell death may be patchy in the brain. Certain localized parts of the brain are more susceptible to anoxia, and other areas are more resistant to anoxia. Fatal anoxic encephalopathy results in clinical “brain death” where the body functions of the heart and internal organs can be maintained by medical life support, but all hope of meaningful recovery is lost. Complications may include persistent vegetative coma, cerebral edema (brain swelling), and herniation of the brain. For patients who do recover consciousness, lifelong brain damage may be observed. The damaged nerve cells have been shown to express a gene product, c-fos, which may be found within anoxically-damaged nerve cells.[31]



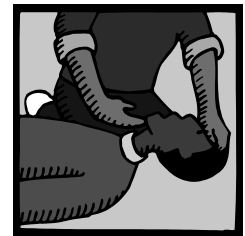
Quantitation of the actual forces applied to the neck is not a meaningful argument. The amount of force required to compress the jugular vein is less than the force to compress the carotid, and that in turn is less than the force required to constrict the airway. However, absolute values -- measured as foot-pounds of force -- must vary tremendously from one person to the next depending on development of neck musculature, and the surface area for the application of force. If the force were applied over a very narrow surface area -- a clothesline ligature as opposed to a broad belt for example -- then much less force would be necessary. Four variables are working simultaneously:





For the same amount of pressure, if you decrease the surface area, or increase the duration of the force, you increase the likelihood that the force will be fatal. Further, if even a small force is applied in just the right anatomic area, the force may obviate the normal anatomic protections of the neck musculature and skeleton. A small woman can easily strangle a large man. The U.S. Army trains “close-range combatives” to use strangulation as a mechanism of lethal force.[32]

Medical resuscitation, and organ procurement procedures, work against the pathologist’s ability to detect fatal homicidal neck injury.[12] An oxygen mask can leave abrasions on the mouth and nasal bridge. During resuscitation, an airway tube is placed into the mouth or nose, and inserted into the esophagus or trachea, to establish a path through which air can be forced under pressure to the lungs. The usual airway device is an oral endotracheal tube, but many varieties of hardware exist. The skill of the rescue staff, and the size and rigidity of the victim, dictate how much injury occurs during this intubation procedure. Traumatic intubations result in internal injuries of the deep musculature of the larynx, often completely mimicking the injuries of strangulation. Ulceration of the larynx may develop from pressure produced by the inflatable cuff on the tube. The mechanical ventilation can produce barotrauma in the lungs, with air dissecting up to the skin of the neck. In cases where the rescue staff is unable to intubate the patient, they might attempt a surgical cricothyroidotomy or tracheostomy procedure to establish an airway. This would completely obliterate all signs of manual strangulation. Further, intravenous needles are sometimes placed into the jugular veins, leaving tracks of hemorrhage that can obscure physical injuries. If resuscitation is successful, the patient may linger on mechanical ventilation for hours or days, resulting in healing of soft tissue injuries in the neck that would have been recognizable if examined earlier. Toxicology is meaningless in patients who survive a





few days in the hospital, so disproving a defense theory that the asphyxial death was caused by overdose of prescribed or abused drugs becomes impossible.

In some communities, organ procurement procedures are routinely performed, regardless of the circumstances of death. A dissection for heart donation can totally obliterate all evidence of injury by manual strangulation. Donation of corneas will obscure observation of petechia in the eyes. The prosecutor is then dependent on the organ procurement team to recognize subtle injuries before they are obscured by the procedure. Few organ procurement technicians or physicians will have any experience whatsoever testifying in murder trials. In the autopsy investigation of strangulation in domestic assault cases, every injury on the body becomes significant. Contusions of the chest wall, abdomen, and extremities become valuable evidence to establish a pattern of abuse. Like child abuse cases, the autopsy strives to illuminate a big picture, not just focus singularly on the neck examination. Each and every bruise and scrape is important. These peripheral injuries can be jeopardized by organ and tissue donation procedures.[33, 34, 35]

References:

1. Gonzales TA : Manual strangulation. *Arch Pathol* 15: 55-65, 1933
2. Kelly M: Trauma to the neck and larynx [Review]. *Crna* 8(1):22-30, 1997 Feb.
3. Missliwetz J, Vycudilik W: Homicide by strangling or dumping with postmortem injuries after heroin poisoning? *American Journal of Forensic Medicine & Pathology* 18(2):211-4, 1997 Jun.
4. Denic N, Huyer DW, Sinal SH, Lantz PE, Smith CR, Silver MM: Cockroach: the omnivorous scavenger. Potential misinterpretation of postmortem injuries. *American Journal of Forensic Medicine & Pathology* 18(2):177-80, 1997 Jun.
5. Samarasekera A, Cooke C: The pathology of hanging deaths in Western Australia. *Pathology* 28(4):334-8, 1996 Nov.
6. Ortmann C, Fechner G: [Unusual findings in death by hanging--reconstruction of capacity for action]. [German] *Archiv fur Kriminologie* 197(3-4):104-10, 1996 Mar-Apr.

7. Howell MA, Guly HR: Near hanging presenting to an accident and emergency department. *Journal of Accident & Emergency Medicine* 13(2):135-6, 1996 Mar.
8. Maxeiner H: "Hidden" laryngeal injuries in homicidal strangulation: How to detect and interpret these findings. *J Forensic Sci* 43 (No. 4): 784-791, 1998 July.
9. Scaglione M, Romano L, Grassi R, Pinto F, Calderazzi A, Pieri L: [Diagnostic approach to acute laryngeal trauma: role of computerized tomography]. [Italian] *Radiologia Medica*. 93(1-2):67-70, 1997 Jan-Feb.
10. Poquet E. Dibiane A. Jourdain C. el-Amine M. Jacob A. Escure MN. [Blunt injury of the larynx by hanging. X-ray computed tomographic aspect]. [French] *Journal de Radiologie*. 76(2-3):107-9, 1995 Feb-Mar.
11. Koiwai EK: Deaths allegedly caused by the use of "choke holds" (Shime-Waza). *J Forensic Sciences* 32 (No. 2): 419-432, March 1987
12. Hood I, Ryan D, and Spitz WU: Resuscitation and petechiae. *Am J Forensic Medicine and Pathology* 9 (No. 1): 35-37, 1988
13. Rao VJ and Wetli CV: The forensic significance of conjunctival petechiae. *Am J Forensic Medicine and Pathology* 9 (No. 1): 32-34, 1988
14. Ely SF, Hirsch CS. Asphyxial deaths and petechiae: a review. *J Forensic Sci* 45(6): 1274-7, Nov. 2000.
15. Soto Campos JG. Garcia Diaz E. Elias T. [Pulmonary edema and mediastinal emphysema caused by strangulation (letter; comment)]. [Spanish] *Archivos de Bronconeumologia*. 31(9):488, 1995 Nov.
16. Cartwright AJ. Degrees of violence and blood spattering associated with manual and ligature strangulation: a retrospective study. *Medicine, Science & the Law*. 35(4):294-302, 1995 Oct.
17. Hammer HJ. [Methods for detection of latent fingerprints from human skin]. [German] *Forensic Science International* 16(No. 1): 35-41, Jul-Aug 1980.
18. Graham D. Some technical aspects of the demonstration and visualization of fingerprints on human skin. *J Forensic Sci* 14(No. 1): 1-12, Jan 1969.
19. Grellner W, Benecke M: The quantitative alteration of the DNA content in strangulation marks is an artefact. *Forensic Science International* 89(1-2):15-20, 1997 Sep 19.
20. Wiegand P, Kleiber M: DNA typing of epithelial cells after strangulation. *International Journal of Legal Medicine* 110(4):181-3, 1997.

21. Pollanen MS. Bulger B. Chiasson DA. The location of hyoid fractures in strangulation revealed by xeroradiography. *Journal of Forensic Sciences*. 40(2):303-5, 1995 Mar.
22. Khokhlov VD: [The mechanisms of the formation of injuries to the hyoid bone and laryngeal and tracheal cartilages in compression of the neck]. [Russian] *Sudebno-Meditsinskaia Ekspertiza* 39(3):13-6, 1996 Jul-Sep.
23. Patel F: Strangulation injuries in children [letter; comment]. *Journal of Trauma* 41(1):171, 1996 Jul.
24. Hanigan WC. Aldag J. Sabo RA. Rose J. Aaland M. Strangulation injuries in children. Part 2. Cerebrovascular hemodynamics. *Journal of Trauma*. 40(1):73-7, 1996 Jan.
25. Sabo RA. Hanigan WC. Flessner K. Rose J. Aaland M. Strangulation injuries in children. Part 1. Clinical analysis [see comments]. *Journal of Trauma*. 40(1):68- 72, 1996 Jan.
26. Pollanen MS. Chiasson DA. Fracture of the hyoid bone in strangulation: comparison of fractured and unfractured hyoids from victims of strangulation. *Journal of Forensic Sciences*. 41(1):110-3, 1996 Jan.
27. Podporinova EE. [Forensic medical expertise in manual strangulations]. [Russian] *Sudebno-Meditsinskaia Ekspertiza*. 39(1):6-9, 1996 Jan-Mar.
28. Anscombe AM, Knight BH: Case report: Delayed death after pressure on the neck: possible causal mechanisms and implications for mode of death in manual strangulation discussed. *Forensic Science International* 78(3):193-7, 1996 Apr 23.
29. Malek AM, Higashida RT, Phatouros CC, Halback VV: A strangled wife. *Lancet* 353(No. 9161): 1324, April 17, 1999.
30. Tournel G, Hubert N, Rouge C, Hedouin V, Gosset D: Complete autoerotic asphyxiation. *Am J Forens Med Path* 22(2): 180-3, June 2001.
31. Nogami M, Takatsu A, Endo N, Ishiyama I: Immunohistochemical localization of c-fos in the nuclei of the medulla oblongata in relation to asphyxia. *Intl J Legal Med* 112(6):351-4, 1999.
32. Field Manual 21-150 "Combatives," U.S. Army Field Training Manual, Sept. 30, 1992, Headquarters, Department of the Army, Washington, D.C., <http://www.adtl.army.mil/cgi-bin/atdl.dll/fm/21-150/toc.htm>.
33. Strack GB, McClane G, Hawley DA: A review of 300 attempted strangulation cases Part I: Criminal legal issues. *Journal of Emergency Medicine* 21(3):303-9, Oct 2001
34. McClane G, Strack GB, Hawley DA: A review of 300 attempted strangulation cases Part II: Non-fatal assaults. *Journal of Emergency Medicine* 21(3):311-5, Oct 2001

35. Hawley DA, McClane G, Strack GB: A review of 300 attempted strangulation cases Part III: Injuries in fatal cases. *Journal of Emergency Medicine* 21(3):317-22, Oct 2001