

A Triad of Laryngeal Hemorrhages in Strangulation: A Report of Eight Cases

REFERENCE: Pollanen MS. A triad of laryngeal hemorrhages in strangulation: a report of eight cases. *J Forensic Sci* 2000;45(3): 614–618.

ABSTRACT: The results of histological studies on larynges from eight cases of manual strangulation, all that had intracartilaginous laryngeal hemorrhages, a recently described and under-recognized lesion associated with strangulation, are reported. Formalin-fixed larynges were examined in serial section using a standardized protocol. In all cases, intracartilaginous laryngeal hemorrhages were associated with subepithelial laryngeal hemorrhages, and intralaryngeal muscular hemorrhages forming a “triad of hemorrhages.” In five cases, the triad was found in the presence of laryngeal cartilage microfractures. Since cartilage microfractures can be causally related to mechanical injury to the neck, it is likely that the triad of hemorrhages has diagnostic value as an independent morphological criterion for the postmortem diagnosis of strangulation. Since a proportion of cases of strangulation lack characteristics that are self-evidently due to violent application of pressure on the neck, recognition of the triad may have important implications for the postmortem diagnosis of strangulation.

KEYWORDS: strangulation, pressure on the neck, asphyxia, larynx, hyoid, petechial hemorrhage, homicide

The most consistently reported gross lesions associated with homicidal neck compression are external injuries of the neck (1–7), injuries of the hyoid-larynx complex (1,2,8–13), and hemorrhagic lesions of various types (14–21). In manual strangulation, both petechiae and larger hemorrhages are commonly found in the conjunctivae, facial skin, soft tissues of the neck, and in the lining of the pharynx and larynx. There is no agreement on the diagnostic specificity of the internal hemorrhages that occur in strangulation and most authorities do not recognize these lesions as indicators of neck compression in the absence of lesions in the neck that are self-evidently due to mechanical injury (e.g., hyoid fracture). Furthermore, the lack of generally accepted morphological diagnostic criteria for strangulation makes the diagnosis difficult, or objectively impossible in cases of putative strangulation that have minimal findings at autopsy (10,22). This diagnostic quandary may be, in part, be solved by the objective and systematic characterization of underrecognized or subtle lesions that occur in strangulation.

Recently, we have described a previously unrecognized lesion in strangulation: the intracartilaginous laryngeal hemorrhage (18). This lesion is common in young female victims of strangulation, and is more frequent than gross injury to the hyoid-larynx complex in this group of cases. In this communication we report the results

of histological studies on larynges from cases of strangulation that all had intracartilaginous laryngeal hemorrhages. The results indicate that this type of hemorrhage is one of a triad of hemorrhagic lesions that are often found in cases of strangulation. The putative diagnostic significance of this “triad of hemorrhage” is indicated by the frequent association of the triad with laryngeal cartilage microfractures. The findings have important implications for the postmortem diagnosis of strangulation, particularly in the suspicious or homicidal deaths of young women that have minimal or obscure findings at autopsy.

Materials and Methods

The larynges from eight cases of manual strangulation, collected at the Office of the Chief Coroner for Ontario (1982–1998) were used for the study (Table 1). All cases were women with an age range of 20 to 50 years old (mean age 26). The diagnosis of manual strangulation was made based on accepted postmortem hallmarks (1–3,6,15) and all cases had intracartilaginous laryngeal hemorrhages (18). All cases had subconjunctival petechial hemorrhages and multifocal deep contusion of the strap muscles of the neck. Seven cases had conspicuous external injury to the anterior neck in the form of abrasions or contusions, with only one case lacking these injuries. Two cases had fractures of the hyoid bone. Only cases with a short postmortem interval were used for the study, to ensure adequate preservation of tissues for histological examination.

Larynges were excised after removal of the brain and organs, using the standard layer-by-layer dissection of neck. After initial examination, the larynges were fixed in 10% neutral buffered formalin. Following fixation, larynges were serially sectioned in the parasagittal plane as previously described (18). Depending on the size of the larynx, a scalpel or a thin knife typically used to slice fixed brains was used to cut the sections. Sections of the fixed larynges were processed for routine paraffin embedding, microtomy, and several 7-micron-thick step serial sections from each block were stained with hematoxylin and eosin. On average, four blocks were prepared from the larynx of each case and four-step serial sections were prepared from each block.

Results

All of the eight cases were selected to have intracartilaginous laryngeal hemorrhages. In all cases these hemorrhages were associated with two other hemorrhagic lesions: subepithelial laryngeal hemorrhage and intralaryngeal muscular hemorrhage. Subepithelial hemorrhages of the larynx ranged from microscopic petechiae to confluent hemorrhage of the lamina propria that sometimes extended into the deep connective tissue stroma, and mucous glands (Fig. 1a and b). In some instances, the subepithelial hemorrhages

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Received 18 June 1999; and in revised form 26 Aug. 1999; accepted 27 Aug. 1999.

TABLE 1—Summary of eight cases of strangulation used in the study.

Case	Age	Sex	External Injury to the Neck	Soft Tissue Neck Hemorrhage	Subconjunctival Petechiae	Fracture of Hyoid
1	35	F	+	+	+	—
2	24	F	+	+	+	—
3	50	F	—	+	+	+
4	31	F	+	+	+	+
5	23	F	+	+	+	—
6	20	F	+	+	+	—
7	21	F	+	+	+	—
8	20	F	+	+	+	—

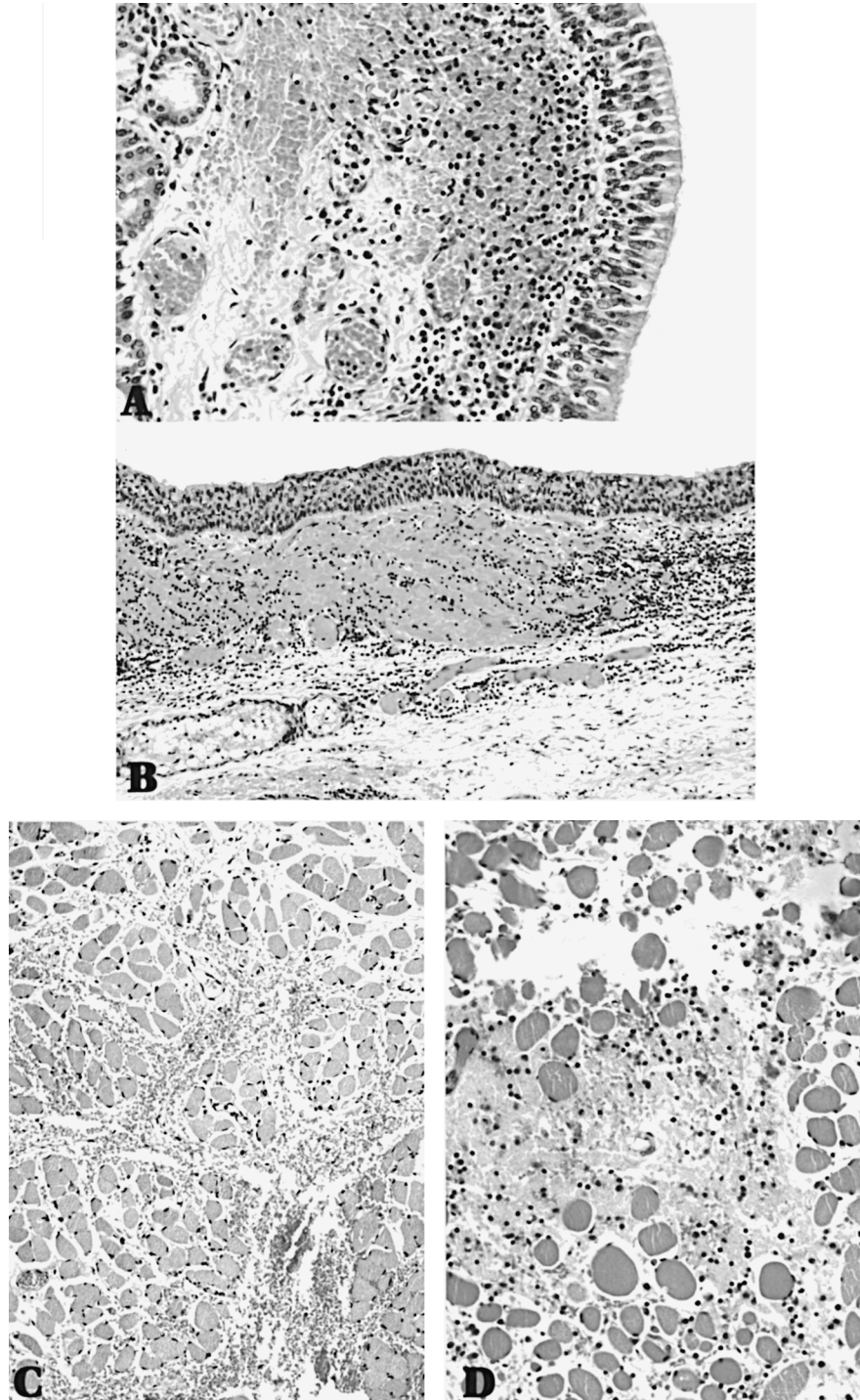


FIG. 1—Hemorrhagic lesions of strangulation. (A) Subepithelial laryngeal hemorrhage ($\times 400$. Haematoxylin and Eosin); (B) Subepithelial pharyngeal hemorrhage ($\times 250$. Haematoxylin and Eosin); (C) Intralaryngeal muscular hemorrhage; ($\times 250$. Haematoxylin and Eosin); (D) Intralaryngeal muscular hemorrhage with local accumulation of platelets and polymorphonuclear leucocytes ($\times 400$. Haematoxylin and Eosin).

were continuous with hemorrhages into the dense connective tissue of the perichondrium. Intralaryngeal muscular hemorrhages were represented by extravasations of blood into the intrinsic muscles (e.g., cricoarytenoides) located deep inside the larynx (Fig. 1c and d). These hemorrhages were mostly limited to the interstitium but sometimes were continuous with hemorrhages of the laryngeal lamina propria or perichondrium.

In addition to the concurrence of these hemorrhagic lesions, five cases also had microfractures of the laryngeal cartilage (Fig. 2). These microscopic fractures were represented by linear disruptions within the chondral matrix, usually involving the cricoid cartilage. The typical cricoid microfracture had a fracture line, containing

fragments of chondral matrix mixed with blood cells, that traversed the body of the cricoid extending to the perichondrium. At the point where the fracture met the perichondrium there was local acute hemorrhage that may spread for some distance in the plane between the perichondrium and cricoid body. Another morphological pattern often observed was the formation of the fracture line at the site of an ossification center in the cricoid. A center of endochondral ossification is present at the inferior portion of the cricoid and microfractures often occur at this site, along the interface between the bone and cartilage.

The intracartilaginous laryngeal hemorrhage appeared as extravasation of blood into the perivascular space associated with the

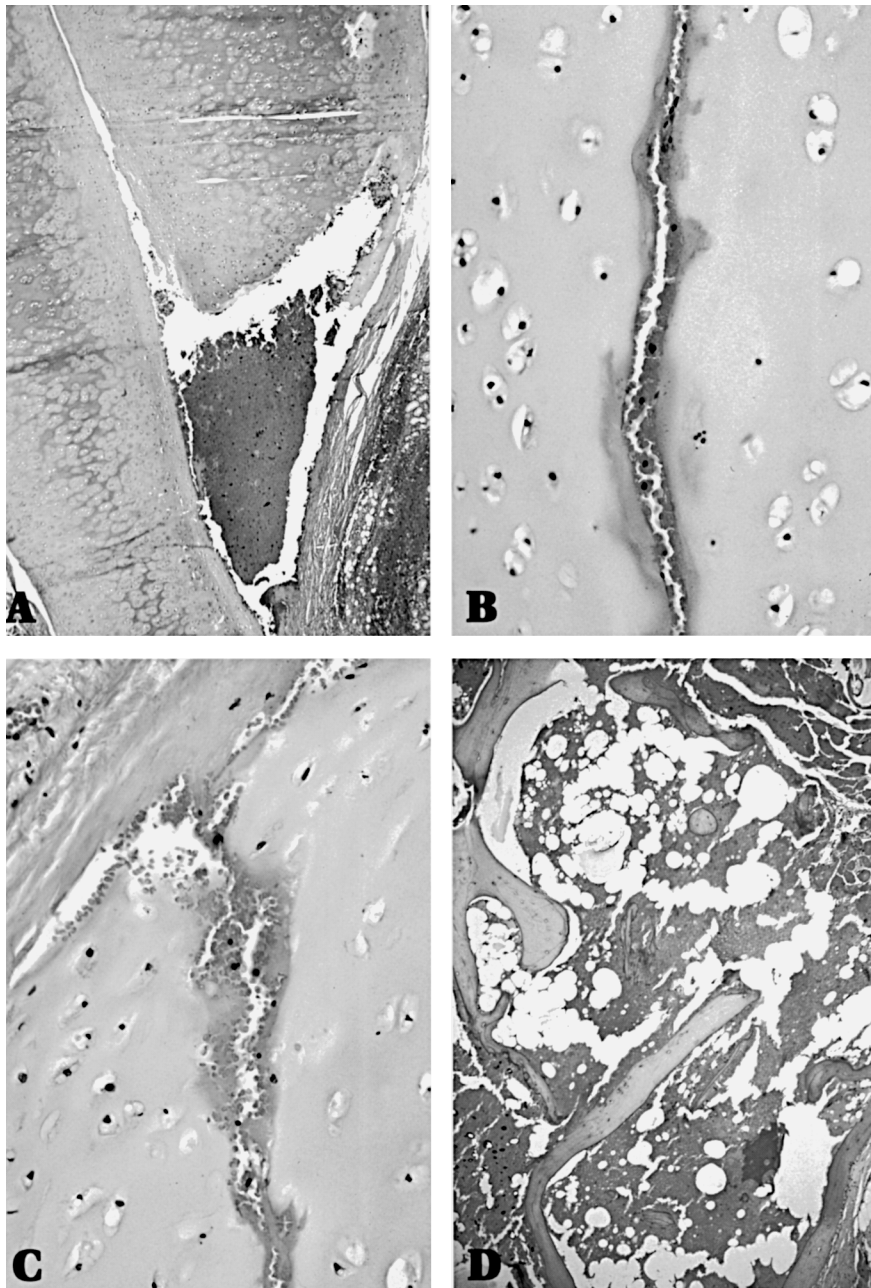


FIG. 2—Laryngeal cartilage microfracture. (A) Inferior pole of cricoid cartilage with fracture and local accumulation of blood into the chondral defect ($\times 100$. Haematoxylin and Eosin); (B) Typical laryngeal cartilage microfracture with a width of approximately $50 \mu\text{m}$ ($\times 400$. Haematoxylin and Eosin); (C) Laryngeal cartilage microfracture at point of intersection with perichondrium ($\times 400$. Haematoxylin and Eosin); (D) Accumulation of blood between bony trabeculae near a fracture of a partially ossified cricoid cartilage. ($\times 250$. Haematoxylin and Eosin).

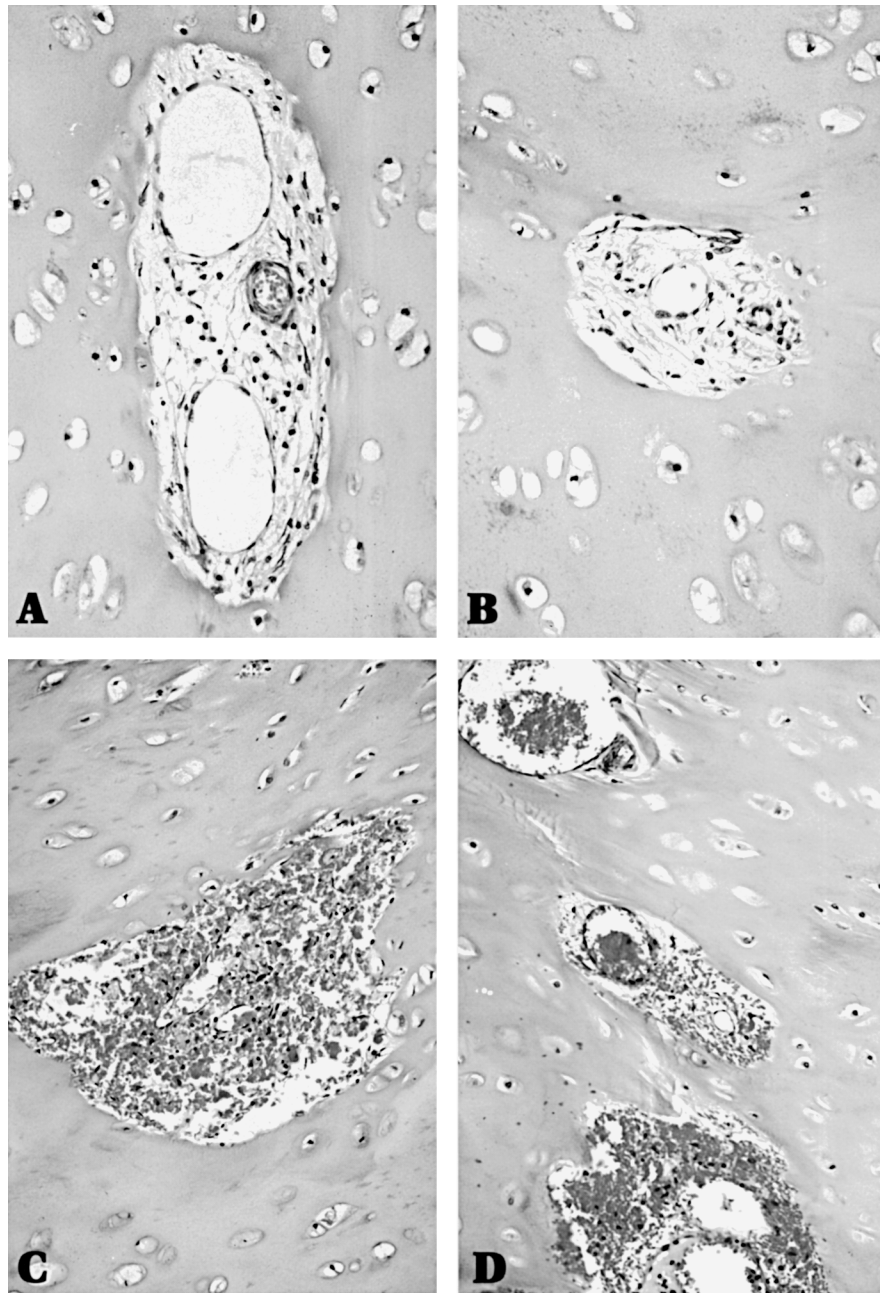


FIG. 3—Laryngeal cartilage blood vessels and intracartilaginous laryngeal hemorrhages. (A, B) Typical blood vessels found in normal laryngeal cartilage. (C, D) Intracartilaginous laryngeal hemorrhages characterized by extravasation of blood into the perivascular or lacunar space in the chondral matrix ($\times 400$. Haematoxylin and Eosin).

blood vessels that penetrate into the laryngeal cartilage, as previously described (Fig. 3c and d). In uninjured regions of the laryngeal cartilage, normal penetrating blood vessels in chondral lacunae were often observed (Fig. 3a and b).

In summary, all cases had intracartilaginous laryngeal hemorrhages, subepithelial laryngeal hemorrhages, and intralaryngeal muscular hemorrhages (Table 2). Five cases had the three hemorrhagic lesions and laryngeal cartilage microfractures (Table 2). The cartilage microfractures involved the cricoid in three cases and, in two cases, the lamina of the thyroid cartilage was involved. In two cases, the fracture line was present at the interface between bone and cartilage at sites of endochondral ossification.

TABLE 2—Laryngeal lesions in eight cases of strangulation.

Case	Intracartilaginous Laryngeal Hemorrhage	Subepithelial Laryngeal Hemorrhage	Intralaryngeal Muscular Hemorrhage	Laryngeal Cartilage Microfracture
1	+	+	+	+
2	+	+	+	+
3	+	+	+	+
4	+	+	+	+
5	+	+	+	+
6	+	+	+	-
7	+	+	+	-
8	+	+	+	-

Discussion

The main result of this study is that a triad of hemorrhagic lesions (intra-cartilaginous laryngeal hemorrhage, subepithelial laryngeal hemorrhage, and intralaryngeal muscular hemorrhage) commonly occur in cases of classical manual strangulation of young women. The putative diagnostic significance of this triad is indicated by the common association of the triad with laryngeal cartilage microfracture. Unlike the individual elements of the triad, laryngeal cartilage microfracture can be directly and causally linked to mechanical injury to the neck. On this basis, the individual elements of the triad can be indirectly linked to pressure on the neck. This makes mechanistic sense since the various laryngeal hemorrhages are likely due to rupture of congested blood vessels caused by obstruction of laryngeal venous drainage due to manual neck compression. A similar mechanism has been invoked for the subconjunctival petechial hemorrhages since the eye is in the venous drainage territory of the jugular venous system (1).

In this series of classical strangulations, only two cases had fractured hyoid bones. This is not unusual given that most of the cases, in this study, were young women who typically lack hyoid fracture (12,23,24). In these two cases, laryngeal cartilage microfracture was also found. However, cartilage microfractures were also apparent in three other cases that lacked any gross injury to the hyoid-larynx complex. This is consistent with the interpretation that laryngeal cartilage microfracture are the most common type of fracture in young female victims of strangulation.

The existence of the triad and cartilage microfracture in classical cases of strangulation broadens the spectrum of lesions that the pathologist can expect to find in such cases. On this basis, the recognition of the triad or laryngeal cartilage microfracture may contribute to investigation of suspicious and unexpected deaths of young woman that lack the classical signs of strangulation at post-mortem examination. In some cases, the direct morphological evidence for neck compression may be equivocal and cannot be interpreted with certainty due to a paucity of lesions (22,25). It seems likely that rare cases of strangulation, that might be otherwise difficult to diagnose at autopsy, will have the lesions described in this paper.

The main issue that remains to be fully investigated is the specificity of the triad to determine the extent of its evidentiary value. This can be accomplished by studying the occurrence of the triad of hemorrhages in other modes of neck compression, and in sudden natural death. In some cases of hanging with incomplete suspension, drowning, and sudden cardiac death there may be subepithelial laryngeal and pharyngeal hemorrhages. However, the author has not documented the concurrence of all components of the triad in nonstrangulation cases. In addition, laryngeal cartilage microfractures have not been observed in any other cases.

In summary, in this report of eight cases of homicidal neck compression, three types of hemorrhagic lesions were observed together in each larynx: (1) intra-cartilaginous laryngeal hemorrhages; (2) intralaryngeal muscular hemorrhages, and (3) subepithelial laryngeal hemorrhages. The occurrence of this triad was strongly correlated with laryngeal cartilage microfractures. The recognition of these lesions may contribute to investigation of suspicious and unexpected deaths of young woman without the

classical signs of strangulation at postmortem examination. In some cases, the direct morphological evidence for neck compression may be equivocal and cannot be interpreted with certainty due to a paucity of lesions. It is likely that some cases of strangulation, which otherwise might be difficult to diagnose at autopsy, will have the lesions described in this paper.

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