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## SOME IMPORTANT SIDE EFFECTS OF TRAUMA

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Dr. Donovan received his B.A. degree from the University of North Dakota in 1940 and his M.D. degree from Loyola University in 1943. After interning in San Antonio, Texas, he served twenty-nine months as an Air Force Medical Officer, then spent eighteen months as resident in Internal Medicine at a Chicago hospital. Following that he accepted a one-year Fellowship in Internal Medicine at Lahey Clinic, Boston, and remained there a second year on a Fellowship in Gastroenterology. For the past nine years he has practiced Internal Medicine in Denver. He has been certified by the American Boards of Internal Medicine and of Gastroenterology. Presently he is an Assistant Professor of Clinical Medicine at the University of Colorado Medical School as well as a member of several medical societies and Denver hospital staffs.



The causal relation of injury to disease is often a major factor in evaluating the extent of disability. Pathologic states resulting from injury or disease are recognized through well established diagnostic patterns included in the symptoms, clinical findings, and laboratory investigations. Chronic disease states claimed to be due to an injury are usually found to have no actual causal relationship except that there was no knowledge of the existence of the disease and that there was no disability until after the injury. Therefore, it is often concluded that the injury must have produced the disease. Physical abnormalities, physiologic variations and potential disease states are common to all individuals, but may not become recognized until an injury has led to a thorough examination. The capable, highly trained medical examiner should have little difficulty in differentiating the results of a true injury from those of a disease, where the two states exist as a confusing factor in determining the extent of disability. An examiner less alert to the psychological twists of the mind arising from disability claims may accept everything that the claimant says relative to the injury and fail to investigate thoroughly the facts relative to any pre-existing anomaly or disease. Repeated assertions that the injury caused the disability eventually convince those who listen that there must be truth in such claims. Injury may be related to disease in three different types of circumstances:

### 1. *Injury as an actual cause of the disease.*

In order to be the cause of a disease state an injury must primarily produce and cause to exist the pathology leading to disability. In the case of many diseases fairly rigid limits must be set within which a disease must occur if it is to be adjudged the result of trauma. These limits involve the following six considerations: (1) the scientific recognition of trauma as a cause of disease; (2) the physical state of the individual before injury; (3) the lapse of time between the trauma and the onset of the disease; (4) the absence of causes of disease other than trauma; (5) the severity of the injury as related to the disease; (6) disease as the cause of the accident.

There are certain diseases in which it is recognized that injury may play a role as a true precipitating cause. There are other diseases in which it is well recognized that trauma does not, in any way, play a role.

The medical examiner should use common sense and scientific logic as well as his knowledge of medicine in deciding the extent to which trauma has been the cause of the disabling disease. Therefore, it is necessary to know as much as possible of the physical state of the individual preceding his injury including definite details regarding the exact mode of onset, the site of the injury, and the exact time of finding or recognizing the disease state. The site of the injury and its relation to the site of the disease must be considered. For example, an injury might precipitate local effects of a latent disease, such as diabetes or arteriosclerosis, to the extent that there would be gangrene of the foot following a blow to the leg or foot. Likewise, an individual with chronic arthritis of the spine might have a severe strain or other type of back injury in which pain would persist as a prominent symptom for a much longer period of time than where injury alone was present. It must be determined how much of the continued disability is due to the injury and the extent that is due to the arthritis. Thorough investigation of preceding symptoms may show that the actual results of injury have ceased and that the existing disability is not greater than would be expected from the progress of the disease, irrespective of the injury.

An injury uncomplicated by a disease gradually recovers over a recognized normal period of time to a maximum healing state which results in a complete restoration to normal function, or ends in a limited state of function resulting in disability. Where there is a time interval between the injury and the onset of a disease, progress to full recovery may be slow or may be reversed into a worse condition and may result in disability much more severe than the same injury in a completely normal person. When the disease is alleged to have been caused by the trauma, the physician should inquire with great care into the symptoms and signs that appeared immediately afterward. He should ascertain the character, the duration, the localization, and the extent of immediate disability. The lapse of time between the injury and the recognition of the disease may be reasonable in some instances and very unreasonable in others.

If a detailed investigation reveals no other possible cause of the disease and disability, other than the trauma, an injury may be said to be the actual cause of the disease.

The actual severity of the injury as it relates to the disease must also be taken in account and there must be compatibility between the severity of the injury and the disability or disease manifested by the patient.

Some diseases develop so slowly and insidiously that they are not noticed until an accident occurs, and even though the accident is trivial, the resulting trauma may seem to be the only likely cause. For example, epilepsy attributed to a head injury may be caused by a slowly growing brain tumor. A recognized disease state may exist in an individual to such an extent that he may become clumsy or may in some way misjudge his activity and be injured through an accident. This is seen in certain nervous system diseases such as lateral sclerosis, tabes dorsalis, brain tumor, or in certain diseases associated with an abnormally low blood sugar condition as is seen in certain tumors of the pancreas.

### *2. Injury as an aggravating factor of pre-existing disease.*

The existence of a disease of acute or chronic nature prior to the date of an alleged injury, must be determined chiefly by obtaining complete details in the history of the case. The effect of the injury on the disease state is estimated by judging the physical state as it must have been at the time of injury and comparing it with the disease state at the time of the examination. Probably the most common disease to cause controversy in relation to trauma is that of degenerative arthritides of the spine. The patient usually has no knowledge of the spurlike formations on his vertebral bodies until revealed by an X-ray. This is usually taken after an injury has occurred to his back, and he may never have had any symptoms in his back previous to the injury. However, an X-ray taken after the injury may show shadows of calcareous bony overgrowths much too extensive to be merely that of callous resulting from the injury. In such cases it is often necessary to render an opinion as to whether the injury or the disease is the perpetuating factor in the disability, and it is also necessary to differentiate the extent of permanent disability due to the injury from that due to the diseased state itself.

### *3. Injury in addition to some unrelated systemic disease.*

The third relationship of injury to disease occurs when the individual becomes injured but fails to recover promptly because he has high blood pressure, diabetes, arteriosclerosis, or some other disease state. The injury may heal and in no way be involved in the chronic systemic disease. At the same time the gradual inroads of the disease may have made recognized progress to the extent that it is now causing the disability which started with an injury. In this case there is a point in time which must be recognized. It occurs when the injury ceases to exist and the disability continues; caused by the chronic disease. For example, one might have an injury, and, while this was healing, develop a coronary thrombosis in no way related to the injury but secondary to previous high blood pressure and arteriosclerosis.

Having given in the preceding paragraphs a discussion of the various types of circumstances in which injury may be related to disease, the remainder of this discussion will be devoted to reviewing some of the more important medical problems as seen by the internist in their relation to injury, such as traumatic heart disease, peptic ulcer, and the relationship of cancer and trauma.

### TRAUMATIC HEART DISEASE

Traumatic heart disease includes the anatomic lesions and functional disturbances of the heart which result from external injury or from an intense, unusual physical exertion. According to the causative mechanism, cardiac trauma may be classified into three main types: (1) penetrating lesions of the chest wall; (2) non-penetrating lesions; (3) physical strain.

Penetrating lesions are commonly caused by bullets, knives, ice picks, needles and glass fragments following auto accidents, or caused when the heart is torn by the sharp ends of broken ribs. Injury to a coronary artery is a common complication of cardiac wounds and although uninjured, the coronary artery may have to be ligated during cardiac suture. The interventricular septum may be injured and the nervous conduction system controlling the heart beat interrupted. The chordae tendinae or papillary muscles may be torn with consequent valvular insufficiency and cardiac strain. A thrombus<sup>1</sup> may develop at the site of injury and cerebral, pulmonary, or peripheral embolization<sup>2</sup> may result from such thrombi which have formed on the wall of the heart. The symptoms and signs associated with penetrating lesions of the heart are caused by hemorrhage, acute cardiac tamponade,<sup>3</sup> pericarditis, contusion or infarction of heart muscle, valvular rupture or an embolism. The electrocardiogram may show evidence of pericarditis, bundle branch block, or myocardial infarction.<sup>4</sup> The T wave inversions may persist for many months or years, but usually they revert to normal after three or four months. The important point to remember is that electrocardiographic changes represent the most constant evidence of cardiac involvement in penetrating chest wounds; their subsidence or persistence may be a reliable index of the functional or organic basis of symptoms which remain for a long time after operation.

In non-penetrating injuries cardiac damage may occur from blunt injury to the chest wall. However, one should be cautioned against attributing to a preceding trauma a host of unrelated cardiac disturbances which are the consequences of the natural course of underlying and independent organic heart disease. Non-penetrating injuries occur in steering wheel accidents, chest being run over by an auto, blow of a fist, kick to the chest, golfball or baseball at high speed, by heavy falling or swinging objects, and com-

<sup>1</sup> A plug or clot in a blood vessel or in one of the cavities of the heart, formed by coagulation of the blood. (All definitions herein are from the Am. Illus. Med. Dict. (21st ed. 1948). Editor.)

<sup>2</sup> Embolism: The sudden blocking of an artery or vein by a clot or obstruction.

<sup>3</sup> Cardiac tamponade: Acute compression of the heart due to effusion of the fluid into the pericardium or to the collection of blood in the pericardium from rupture of the heart or a coronary vessel.

<sup>4</sup> Infarct: An area of coagulation necrosis in a tissue . . . resulting from obstruction of circulation to the area.

pression of the chest between two moving objects. Serious contusion and even rupture of the heart may occur without any significant visible external injury of the chest wall and without fracture of the ribs. These bruised and contused areas of the heart muscle may heal with the formation of a firm scar, indistinguishable from the scar of a cardiac infarct due to coronary artery occlusion, but certainly with a prognosis much better than when this scar is secondary to a coronary artery occlusion. Direct trauma does not cause coronary artery disease. Coronary occlusion is caused by degenerative vascular changes and arteriosclerosis.

There is always doubt about reported instances of damage to the normal heart due to undue physical effort. Doubt usually surrounds the claim that the heart was previously normal. When abnormal heart rhythms develop there is also a question of coincidence, for they not infrequently arise in the normal heart without unusual effort or other apparent cause. In the previously diseased heart, the strain of an intense physical effort apparently may induce the abnormal rhythms, rupture of a valve, a paroxysm of angina pectoris, and occasionally congestive heart failure. The normal heart has enough reserve energy to meet the demand of unusual exertion. The diseased heart loses this reserve and is therefore more easily affected than one that is normal. Recovery from injury to the body may be greatly influenced by a pre-existing heart disease or a systemic disorder affecting the heart. It is a great advantage in evaluating the influence of trauma on a pre-existing heart disease if a prior examination has been recorded showing the extent of valvular defects, coronary disease, hypertension, or any variation from the normal rhythm of the heart beat before the sudden intense physical strain. Disease of the heart muscle and heart valves is likely to limit cardiac reserve which results in increased susceptibility to damage by overexertion. The myocardial insufficiency should be evident at the most within a few hours after trauma, if the trauma is to be held responsible for the onset of the symptoms. The normal heart is capable of compensating for physical exertion without damage to its efficiency. On the contrary, lesser strain on an already diseased heart may produce the onset of symptoms of prolonged consequence.

The possible causal relationship of atherosclerotic coronary occlusion to physical strain has come to assume medicolegal importance, particularly in connection with insurance and workmen's compensation cases. The sequence of events after a severe and unusual physical strain strongly suggests that the strain in some way initiated or accelerated the coronary artery occlusion and the consequent myocardial infarction. These cases require careful interpretation for their correct solution. Occasionally a strenuous or unusual exertion occurs in a person with severely narrowed atherosclerotic coronary arteries. The exertion may intensify the coronary insufficiency relative to the needs of the heart muscle so that an area of the heart muscle is subjected to a sudden and severe loss or deficiency of oxygen and as a result injury may occur to the heart muscle. Such cardiac muscle injury may present a clinical picture identical with that of an acute coronary thrombosis with corresponding electrocardiographic changes.

Rupture of a heart valve or supporting muscle may follow a severe physical strain. More often the affected valve is the seat of some pre-existing disease. The aortic valve is most commonly affected and the greater frequency of left-sided valvular injuries may be attributed to the higher intracardiac pressures on that side and to the greater frequency with which these valves are the site of some pre-existing underlying disease.

#### TRAUMATIC PEPTIC ULCER

Violence to the abdomen may rupture the mucosa or lacerate the wall of the stomach. It is conceivable that within a few days the peptic acidity of the gastric juices might affect such a wound to create an ulcer. Where trauma is claimed to be the cause of the peptic ulcer there must be definite proof that no ulcer existed before the onset of the trauma. Any injury that is severe enough to cause actual rupture of the stomach wall or a tear in its inner lining would result in immediate disability or production of symptoms; or at least the symptoms would arise soon after the injury. Aggravation of an already pre-existing peptic ulcer is often involved in a claim that the injury precipitated activity and produced symptoms previously quiescent. This presents a difficult question as there is no way to determine when an ulcer will flare up or produce complications such as hemorrhage or perforation. In the handling of such medicolegal cases where an ulcer is alleged to have been produced by trauma or stress the availability of previous X-rays and medical records, and the history of the patient's symptoms will play a considerable part in properly interpreting whether the patient actually has a new stress ulcer or had pre-existing peptic ulcer disease.

#### TRAUMA AND CANCER

The question whether trauma caused a tumor or accelerated the growth of a previously quiescent tumor at times assumes medicolegal importance. In considering such cases it is important to remember that the incidence of cancer is no higher in previously injured patients than in those without injury. Moreover, there is no evidence from animal experimentation that a mechanical injury is capable of causing cancer to develop in a normal animal. By inference, therefore, mechanical injury would not be capable of causing cancer to develop in a previously normal patient. Whether a mechanical injury can accelerate the growth of a previously quiescent tumor is also a difficult question to answer and the biological interrelationships between the tumor and its host would play a large part in the correct interpretation of such instances.

#### SUMMARY

A discussion has been given of the various ways in which traumatic injuries may be related to disease and subsequent disability occurring in patients who have been subjected to such injuries. The medical aspects of the more common medicolegal problems of traumatic heart disease and traumatic peptic ulcer have been given, and evidence has been presented to contradict the belief that traumatic injuries may cause cancer to arise.