THE RARE INCIDENCE OF ACUTE APPENDICITIS RESULTING FROM EXTERNAL TRAUMA

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THE correct evaluation of external trauma in acute appendicitis is important. Traumatic influences should be judged only on a very critical basis. This is purely a medical problem from the legal viewpoint. Court decisions rest entirely upon expert testimony, and the surgeon who appears as a witness should do so for the purpose of throwing light upon a subject of which the court is ignorant. These decisions are influenced by the attitude of expert witnesses who should be enlightened, frank and helpful. The court expects integrity, and looks to the physician for real information. The broadened conception of the Compensation Law takes cognizance of the secondary, aggravating or contributing effects of injury upon disease. Decisions should rest upon proven facts, not theoretic opinions. Evidence should be overwhelming and leave no doubt. This study was prompted in order to determine the relation of external trauma to the occurrence of acute appendicitis, and was based upon: (1) nine personal cases; (2) a review of continental and American literature; (3) 48 litigated cases; and (4) a survey of current surgical thought.*

It is conceded that the appendix is not immune to injury. It is believed, however, that the majority of cases reported as traumatic appendicitis are misnamed. In the evaluation of traumatic influence, five essentials must be united and correlated: *i.e.,* (1) the history; (2) the force; (3) the mechanism; (4) elapsed time between the accident; the development of the disease and operation; (5) the pathology demonstrated at operation.

The History.—The fact that appendicitis may have antedated the accident may be withheld by the patient, in an attempt to place the entire blame upon the injury. It is stressed, therefore, that the history in such cases may be entirely valueless. In several of my cases, an accident was first blamed, and later when the patient entered the hospital for operation, no mention was made of the accident, to the intern who took the history. The previous state of health in Kelly's series is not mentioned in 35 cases. It was reported "good" in 13. It is noted that a history of previous attacks was obtained in only two cases.

The Force.—The application of blunt force, over the appendix region, run-over accidents of crushing violence or pinioning the abdomen against an immovable object with sudden disturbance of intra-abdominal pressure, are direct types. Indirect forms of violence of less significance are falls upon regions other

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than the abdomen, prolonged exertion of dancing, skipping rope, bicycle riding, playing golf or tennis. Lifting heavy objects may be alleged to be the cause in industry. Exertion was mentioned in 20 of Kelly's cases, falls in six and direct blows in 24. In no instance was there any external evidence of injury to the abdominal wall.

Mechanism.—Increased intra-abdominal pressure is involved in direct injury. Sudden muscular action, involving strain, is blamed in indirect. The direct force, when applied to the abdomen, is transmitted through the wall, to

TABLE I

INCIDENCE

Reported by	Cases	History of Trauma	Percentage	Children	Cases	Percentage
Speed	313	3	0.9	313	3	0.95
Ray	600	3	0.5	....	..	....
Borchard, Opitz	150	3	2.0	....	..	....
Block	....	..	2.0	....	..	....
Sewall	....	..	75–80	....	..	....
Van Neuman	....	..	6.6	....	..	....
Steiner	400	4	1.0	....	..	....
Wilhelm	940	3	0.3	....	..	....
Bissell	....	..	4.0	....	..	....
Ochsner	3,300	9	0.2	....	..	....
Hawkes, Stewart	4,300	3	0.7	....	..	....
Maes	1,260	6	0.4	1,260	6	0.47
Levai	....	..	0.85	....	..	....
Fox, Zerbe	1,700	1	0.14	....	..	....
Ebner	....	..	0.8	....	..	....
Hawkins	....	..	8.4	....	..	....
Sonnenberg	....	..	2.0	....	..	....
Nudeleman	....	..	1.2	....	..	....
Stern	533	13	2.0	....	..	....
Totals	13,496	48	0.3	1,573	9	0.57

the contents beneath, consisting of gaseous, fluid, semifluid, and solid media, subject to displacement and pressure changes. Fixed structures are subject to greater stress than those loosely attached. Pressure within the appendix may be increased by any force which decreases intra-abdominal space. This force must be suddenly exerted. A direct blow suddenly throws the abdominal muscles into a state of violent contraction. Blows or falls on the back, or back injuries, usually have no relationship to appendicitis, because of the large powerful muscles which form the posterior abdominal wall. The state of the abdominal muscles and the thickness of the wall at the time of impact are important considerations. An appendix is more readily injured when the muscles are flaccid than when rigid. In a recent personal communication, Dr. Robert T. Morris cited the case of a farrier who was kicked in the abdomen by a horse. He states: "At operation, the blow apparently lifted the cecum

out of position. When it returned, the appendix became twisted upon its mesentery and both lumen and blood supply were obstructed." Deep, rough palpation of a thin, relaxed abdominal wall, in the course of examination by the surgeon, may arouse a dormant appendix. It is necessary to consider separately the intimate modus operandi of trauma upon an already diseased appendix. Under such conditions a direct blow or crushing injury delivered over the cecum may cause a true traumatic lesion or forcible expulsion of gas and fecal contents into the organ. In this connection we must consider the rôle of the fecalith. Medical opinion concedes that the presence of a fecal concretion or foreign body is definite evidence of disease, though such an appendix may remain clinically quiescent. In the potential obstructive type caused by fecaliths, the luminal pressure increases following a blow upon the abdomen. Minute fissures in the mucosa or lacerations may occur permitting invasion by bacteria into the submucous coats. These conditions furnish the factors necessary for complete obstruction, attended with stasis, inadequate drainage, defective circulation, and the final stage of gangrene, and spontaneous perforation. The mechanism of the blow delivered over the cecum is much the same as that which operates in the case of a cathartic. The effect is the same sudden peristaltic action, the one being external, the other internal. The injection of opaque media under high pressure, for the purpose of roentgenologic visualization of the colon and appendix, may result in such a degree of inflation as to induce a recurrent appendicitis.

As to indirect trauma, Byron Robinson advanced the theory that action of the psoas muscle may act as a mechanical factor in causing appendicitis, in those cases in which the organ lies upon the muscle. Powerful contractions of this muscle, and perhaps the iliacus, according to this author, irritate the appendix, causing adhesions, bands, angulations, kinks or obstructions. It is, therefore, conceivable that an appendix already handicapped by such pathology might be further aroused when firmly adherent to these muscles, by repeated acute flexion of the thigh upon the trunk as in bicycling. Kelly reports the case of a boy who was turned upside down in play, and whose appendix was found to have been freshly penetrated by a pin. There were no adhesions. The pin had remained innocuous until the unusual sudden change in posture had shifted its position. This would appear to be an example of both indirect external trauma, and direct internal trauma operating upon a diseased appendix. The mechanism of indirect force, strain, or violent effort may be attributed to action of the abdominal muscles, as in the case of a clerk, also reported by Kelly, who attempted to lift a heavy object above his head, while standing on a ladder which shifted its position. He was forced to suddenly exert himself, causing a violent strain on the abdominal muscles, resulting in acute pain, which persisted for ten days, when he died. Autopsy revealed general peritonitis from a ruptured appendiceal abscess. E. Staude reported typical symptoms developing in a boy who had scrubbed a floor. This occupation involved rotating movements of the trunk and sudden assumption of the erect posture from a crouching position. At operation, a free appendix was located, with a very long

mesentery which had undergone 360° of torsion. It was readily untwisted, and was the seat of edema, punctuate hemorrhages, and filled to capacity with feces. Similar cases are described by Oesch, Ringel and Routier. The trauma of transporting a case of advanced appendicitis, in an ambulance over rough roads, may precipitate a rupture. Contortions, as the case of the famous Houdini, may be held liable for rupture of an appendiceal abscess (DeWitt Stetten).

Finally, the expulsion of cecal contents into the appendix is the common explanation of the mechanism inducing many so-called cases of acute primary traumatic appendicitis following a direct blow, without a prior history of appendicitis, *without evidence of prior pathology or genuine traumatic pathology at operation.* It assumes a previously normal appendix. It is a theory which cannot be conceded.

Elapsed Interval between Injury and Symptoms.—If the trauma has forced the patient to stop work at once and he has since had continuous trouble, its importance has to be recognized. Pain is a source of immediate complaint within a few hours. It has been stated that if symptoms develop after 48 hours, responsibility for the accident may be rejected. The longest interval admissible, between trauma and first manifestations, is 48 hours, according to Bruening. Jottkowitz acknowledges an interval of two or three days if there has been a bridging of symptoms. A study of the elapsed time between the injury and development of symptoms in Kelly's cases shows that 42 cases developed within 48 hours.

Pathology.—Genuine traumatic pathology is very rarely demonstrable in the appendix, when compared with the frequency with which contusion, hematoma, laceration, and rupture or perforation are encountered in other abdominal organs. These lesions should be designated as such, and not as traumatic appendicitis, unless it has been proven beyond doubt microscopically that the necessary inflammatory reaction is a sequence. Gutzeit, Oesch, Fox and Zerbe have each encountered a case in which true traumatic lesions were demonstrated at immediate operation, and which on microscopic examination showed no appendicitis. Table II shows examples of true lesions. Potential morbid conditions which make for ready further bacterial invasion after direct abdominal injury are angulations, bands, adhesions and a shortened mesentery. Conditions within the appendix are an incompetent Gerlach valve action, strictures, concretions and foreign bodies. It is conceded that many and varied are the already existing lesions which may be lighted up by trauma. It is conceivable that certain definite bands or adhesions may be the seat of actual laceration, or proof may be present at immediate operation that an abscess was actually ruptured by a direct blow or by exertion of indirect violence.

Brunig has made a comparative study of concretions in cases in which no trauma figured in the history and in cases in which trauma appeared. In nontraumatic histories, concretions were found in 35 per cent and in traumatic

histories in 65 per cent. This has not been confirmed. The local lesions, according to Desmarest, are, in the majority of cases, due to a partial gangrene of the appendix. This observation was also made by Kelly. In 37 of his 50 cases, the appendix was gangrenous or perforated. In the majority, the lesion was of an advanced obstructive type. A fecalith was found in 30 cases. There were no true traumatic lesions.

The final diagnosis should be made microscopically in conjunction with the clinical history. This necessity is shown in a case reported by K. A. Bartels of a farmer, age 27, who was kicked by a calf. Operation disclosed an acutely inflamed appendix, fresh adhesions, fibrinous exudate and signs of hemorrhage—all indicative of recent pathology. The microscopic examination, however, revealed a carcinoid condition. Maes in commenting upon this case, states: "This surely cannot be classified as traumatic appendicitis."

TABLE II

TRAUMATIC LESIONS

Traumatic lesions without superimposed appendicitis (diagnosed microscopically)	3
Appendix	
(1) Perforation	2
(2) Laceration	3
(3) Hemorrhagic suffusion, subserous, diffuse, local ecchymosis	3
(4) Avulsion of serosa—also adjacent ileum and cecum	2
Mesentery	
(1) Laceration, rupture of appendicular artery	3
(2) Hematoma, subserous	2
(3) Ecchymosis, also adjacent ileum	1
Appendix and Mesentery	
Hemorrhage into	1
Ascending Colon	
Rupture terminal branch ileocolic artery	1
Cecum and Ileocecal region	
Ecchymosis	2
Total	23

It cannot. It does, however, present a typical example of acute pathology resulting from trauma, superimposed upon a chronic lesion, and constitutes definite evidence of aggravation. It is urged that a very careful examination of the surrounding parts be made by the surgeon at operation and of the specimen by the pathologist in potential medicolegal cases. Is the pathology exclusively recent or old or is there fresh pathology superimposed upon a chronic lesion? This determination is essential. The presence or absence of a fecalith may be a highly significant factor. The appendix should be split and examined for strictures, fecaliths and foreign bodies. Adhesions should be particularly noted, whether old or recent. Measurements should be taken and the specimen preserved as an exhibit. Fecaliths indicate old pathology and should always be crushed to determine the character of the nucleus.

PERSONALLY OBSERVED CASES IN WHICH TRAUMA WAS A FACTOR.—Nine cases have been studied, of which eight were adult males. Their ages varied

from 12 to 46. The interval between the accident and the symptoms varied from immediate development to six months. Operation was performed within a few hours in three, 23 days in three, three months in two and after six months in one. Four cases gave an antecedent history of appendicitis. Seven followed indirect injury. Hospital records failed to indicate any history of injury in four, though claims for injury were made to insurance companies which had to be evaluated and defended. Critical analyses submitted to the defendants' attorneys in three cases were successful in having the claims withdrawn. In one instance there was an ecchymosis in the right lower quadrant. There was no genuine traumatic pathology in the appendix or its vicinity in any case. Two were chronic lesions, one with a fecalith, one rectrocecal and kinked. One was chronic (acknowledged dormant) with an acute superimposed catarrhal appendicitis. Six were acute lesions, of which four were gangrenous. One was acutely inflamed and distended. One was much elongated, taut and adherent.

Five of the cases were tried. Two were based upon aggravation and three upon origination. Two were compensation cases. Both were won by the plaintiff. One was based upon origination due to indirect violence, which was finally decided on appeal, and one was based upon aggravation due to a direct blow. There were four verdicts for the plaintiff. Two of these were tried upon the basis of origination and two upon aggravation. One was the result of an appeal. One verdict, for $11,000, was obtained for one plaintiff upon the basis of aggravation by a direct blow, in which a latent appendicitis was thought to exist without symptoms; showing at operation, 23 days after the accident, an acute catarrhal, retrocecal appendix with old, dense adhesions. There were two death claims. One was not pressed. In the other—the one suit which resulted in a verdict for the defendant—appendicitis followed an alleged back injury six months after the accident, when operation disclosed a gangrenous, perforative appendicitis with peritonitis. In the four cases with prior attacks, no claim was made in one, and in two the claims were dropped, because the hospital record, later, failed to support a history of an injury which had been previously reported to the insurance carrier. One death claim was also dropped because of the absence of a history of injury on the hospital record. Of four verdicts for the plaintiff, direct violence occurred in two, indirect in two (Table III).

Collective Review.—Fifty cases reported as primary traumatic appendicitis without previous attacks or prior evidence of disease at operation have been submitted in personal communications and collected from current literature. Scrutinized under strict criteria, only about 20 escape exclusion. Three were genuine traumatic lesions in which microscopic examination failed to reveal appendicitis and have been ruled out. The remaining were reported on a primary basis, without evidence of trauma at operation, and only the usual inflammatory changes to support the author's contention. In these, records are incomplete. The time element criterion has not always been fulfilled. In others operation had been long delayed. Acceptance upon a

TABLE III

SYNOPSIS OF NINE PERSONALLY OBSERVED CASES IN WHICH TRAUMA WAS A FACTOR

Age	Sex	Interval between Accident, Symptoms and Operation	Antecedent History of Appendicitis	Violence	Basis of Claim	Lesion	Result of Litigation
12.....	Male	24 hours	Present	Indirect	None	Gangrenous, fecalith	
18.....	Male	20 days	None	Indirect	Origination	Gangrenous	$2,100 for plaintiff
36.....	Male	Immediately, operation in 3 months	Present	Direct	Aggravation, also Tbc.	Chronic, fecalith	25 per cent of total permanent for petitioner
46.....	Male	24 hours	Present	Indirect	Aggravation	Acute, elongated, taut, adherent	Claim dropped
30.....	Male	Immediately, operation in 23 days	None	Direct	Aggravation	Retrocecal, acute catarrhal, old adhesions	$11,000 for plaintiff
35.....	Male	6 months	None	Indirect	Origination, two counts	Retrocecal, angulated, gangrenous	(1) For def. in case of appendicitis, death claim. (2) $30,000 for plaintiff in back injury
46.....	Male	3 months	None	Indirect	Origination	Gangrenous	Death claim dropped
34.....	Male	7 hours	None	Indirect	Origination	Acute, distended	Verdict for plaintiff on appeal
31.....	Female	Immediately, operation in 10 days	Present	Indirect	Aggravation	Retrocecal, chronic, kinked	Claim dropped

primary basis can only be speculative and assumes the expulsion of cecal contents into a normal appendix as the determining factor.

LITIGATED CASES.—Forty-eight operative cases, claiming that trauma produced appendicitis, have been studied. There were 24 verdicts for the plaintiff and 24 cases for the defendant. Six cases were appealed. Three decisions for the plaintiff were finally reversed. One was sustained. One decision in favor of the defendant was later reversed and one in favor of the defendant was sustained. In several cases, claims were allowed by insurance companies without question (two blow cases and one strain case). One was a ruptured appendix without previous symptoms or preexisting pathology. A second is said to have shown evidence of contusion and laceration of the tissues surrounding the appendix. In a third case, a large corporation accepted the claim that appendicitis developed as the result of chasing a runaway horse. The animal was caught and personal injury to bystanders thus averted. This claim was possibly settled as a reward for timely action. Of 24 cases, in which the character of the injury was specific, 12 were due to direct and 12 to indirect violence. There were eight death claims, all of which recovered damages, except one strain case. There were 18 verdicts for the plaintiff and six for the defendant. In 12 indirect injuries, there were eight verdicts for the plaintiff. In the 12 direct injuries, there were ten verdicts for the plaintiff.

SUMMARY.—(1) Appendicitis has been held a compensable injury by the courts; based upon both origination and aggravation, the result of direct as well as indirect violence. (2) Less doubt exists as to casual connection in cases of aggravation than in origination, and in those cases following direct violence than in those following indirect violence. (3) Verdicts in general regardless of whether cases of aggravation or origination, negligence actions or compensation cases, are equally divided between plaintiff and defendant. (4) In cases of direct injury, the courts have favored the plaintiff in the ratio of five to one. (5) In cases of indirect injury verdicts in favor of the plaintiff two to one.

SURVEY OF CURRENT SURGICAL THOUGHT.—In a survey of the opinions of distinguished foreign surgeons, only Sir Arbuthnot Lane believes that external trauma has no relationship whatsoever to appendicitis. Professor Lambert Rogers, of the Surgical Unit, Welsh National School of Medicine, Cardiff, is the only one who favors a primary relationship. There are six who contend that external trauma is purely secondary and may influence only an appendix already diseased. They are Sir William Wheeler, Sir G. Lenthal Cheattle, Sir W. Sampson Handley, Mr. Robert V. Dolbey, all of London, Professor Archibald Young of the University of Glasgow, and Sir David P. D. Wilkie of Edinburgh, though Sir David states in his letter: "It is quite possible that an obstruction (concretion) might be primary by some form of external violence applied to the abdomen." Lord Moynihan, of Leeds, stated he had "no experience in traumatic appendicitis," and offers no opinion with respect to the influence of injury. Professor F. De Quervain, Director

of the Surgical Clinic, University of Bern, Switzerland, expresses a sane and lucid opinion: "One should express himself with great caution about the relationship of external trauma to appendicitis because one never knows what was the condition of the appendix prior to the injury. One finds, so often, slight inflammatory changes even in normal looking appendices on histologic examination that one may inquire how many appendices remain at all normal after reaching maturity. The normal appendix is, as a rule, better protected from traumatic influences than any other part of the G. I. tract, and no part is less inclined to be damaged by trauma than the appendix; this is based on its anatomic structure. When a heavy local contusion really causes damage to the ileocecal region, the participation of the appendix is then of less importance. In many thousands of cases of acute and subacute appendicitis, I have never observed anything which would throw any light on its traumatic origin. It is a different matter when a latent, or really existent appendicitis, is aggravated by a trauma. Even such occurrences take place so seldom that the physician should be very careful in his final opinion. One must add to it the possibility of rupture of an appendicular empyema, or the development of a diffuse peritonitis from a localized periappendicular abscess. In my long clinical observation of 26 years I cannot remember seeing such a case, but I cannot deny its possible occurrence."

Of five opinions expressed by our Canadian colleagues, all accept a definite relationship between trauma and appendicitis. Of these Dr. Stuart D. Gordon, of Toronto, and Dr. L. S. Mackid, of Alberta, accept trauma as a primary factor. Dr. W. A. Lincoln, of the Calgary Associate Clinic, Alberta, Dr. Campbell B. Keenan and Dr. E. W. Archibald, of Montreal, favor acceptance of trauma only as a contributory factor. Polls have been made of three surgical societies: 16 per cent of the Brooklyn Surgical Society deny any influence of trauma, 84 per cent accept it; of the latter, 33 per cent grant it a primary rôle, and 51 per cent acknowledge only a secondary rôle, aggravating a preexisting lesion. Denials of any traumatic influence by the New York Surgical Society are 31 per cent; acceptances 69 per cent, of which 29 per cent acknowledge trauma may be a primary factor and 40 per cent rate it as secondary. No relationship is voted by 24 per cent of the Chicago Surgical Society. Of 76 per cent who concede trauma to be influential, 9 per cent accept it on a primary and 67 per cent on a secondary basis. A survey at large showed 20 per cent opposing trauma as a factor. Of the 80 per cent accepting trauma, 26 per cent accepted a primary rôle and 54 per cent accepted trauma as playing a secondary aggravating rôle. In the final analysis of 243 opinions, 20 per cent deny any relationship, 24 per cent grant a primary influence and 56 per cent a secondary influence (Table IV).

CONCLUSIONS

(1) Appendicitis is a disease and not an accident. It cannot be produced by trauma alone. The primary cause of the disease is bacterial infection,

occurring in a vestigial organ possessing low vital resistance, susceptible to destructive changes on slight provocation. This provocation is furnished by slight abrasions of its mucous membrane from the presence of hardened fecal

TABLE IV

SURVEY OF OPINIONS FROM VARIOUS SOURCES

Opinions	No.	Deny Relationship	Accept Primary Relationship	Accept Secondary Relationship
From the literature	42	9%	38%	53%
Brooklyn Surgical Society	30	16%	33%	51%
New York Surgical Society	60	31%	29%	40%
Chicago Surgical Society	34	24%	9%	67%
Miscellaneous	62	20%	26%	54%
Foreign	10	11%	11%	78%
Canadian	5	0	40%	60%
Totals	243	20%	24%	56%

matter and especially by circulatory disturbances, the result of a shortened mesentery or angulation of the organ.

(2) One must take cognizance of two possibilities: namely, the effects of trauma upon: (1) The normal appendix and, (2) the pathologic appendix. There is substantial evidence to support the belief that both direct and indirect trauma may affect the appendix, but these cases are very rare in comparison with the large number of cases in which trauma has no part.

(3) The question of the correct evaluation of trauma rests largely upon: (1) Whether the patient has had previous attacks of appendicitis; (2) character of the force; (3) the time element; (4) the bridging of symptoms from accident to operation; (5) the pathologic findings at operation; (6) the final microscopic diagnosis.

(4) To admit that genuine primary traumatic appendicitis exists, the following rigid requirements must be met: (1) There must be no history of previous attacks. (2) The causative traumatism must be capable of reaching and affecting the appendix. The injuring body must be large, the force direct, blunt, violent and of limited duration. (3) The effects of the trauma must be immediately experienced, merge into those of acute appendicitis, must be properly reported, be disabling, require medical attention and operation at once. (4) True traumatic lesions of the appendix must be operatively demonstrated, namely, frank contusion, hematoma or effusion in the wall or mesentery, genuine rupture, laceration or puncture. (5) There must be a superimposed acute inflammation of the appendix, the result of the traumatic lesion diagnosed microscopically and no evidence of chronic pathology. Immediate operation may reveal only the true traumatic lesion and no appendicitis on microscopic examination. It is stressed that such lesions should not be called traumatic appendicitis until the inflammatory reaction has developed and been proven microscopically. Without these genuine lesions, coupled

with the necessary inflammatory reaction, the case of primary traumatic appendicitis has not been proven and its occurrence is a coincidence.

(5) To admit the contributory or aggravating influence of trauma, the following postulates are essential: It is stressed that the influence is here entirely secondary and that we are dealing with the traumatic effects upon old, preexisting pathology. The condition should not be called traumatic appendicitis. Appendicitis, aggravated by trauma, is best designated traumatic appendicopathy. The necessary requirements are: (1) There should be elicited a definite history of previous attacks. (2) The history of trauma must here also show a definite sequence and relationship to, and be correlated with, the operative findings. (3) The onset of symptoms characteristic of an exacerbation must develop at once and force the patient to stop work. (4) The occurrence must be properly reported. (5) The operative findings should show, conclusively, either genuine traumatic pathology with an added acute appendicitis or unquestioned pathology antedating the injury, with superimposed acute appendicitis. (6) The microscopic report of the sectioned organ should indicate acute appendicitis.

(6) There are no proofs that chronic appendicitis can be attributed to trauma.

(7) If operation is refused, or if delayed and late operation reveals only chronic microscopic pathology, the case should not be accepted as one of traumatic appendicopathy.

(8) If the attack following the accident sudsides and later recurs, the injury should not be held responsible for the second exacerbation.