E-ISSN: 2616-3470
P-ISSN: 2616-3462

www.surgeryscience.com
2020; 4(2): 158-163
Received: 14-02-2020
Accepted: 15-03-2020

Abdullah Shuaib
Department of General Surgery, Jahra Hospital, Jahra, Kuwait

Mubarak Alasaousi
Resident in Kuwaiti Board of General Surgery, Kuwait Institute of Medical Specializations, Kuwait

Ahmed M Gawali
Department of General Surgery, Jahra Hospital, Jahra, Kuwait

Mohamed Alaa Sallam
Department of General Surgery, Jahra Hospital, Jahra, Kuwait

Corresponding Author:
Abdullah Shuaib
Department of General Surgery, Jahra Hospital, Jahra, Kuwait

Traumatic appendicitis: Is it a fairy tale? A literature review

Abdullah Shuaib, Mubarak Alasaousi, Ahmed M Gawali and Mohamed Alaa Sallam

DOI: https://doi.org/10.33545/surgery.2020.v4.i2c.411

Abstract
Acute appendicitis is the most common surgical condition in patients presenting to emergency departments worldwide. It was only in the early 1930s that the relationship between blunt trauma and acute appendicitis was reported. Searches on the terms "traumatic appendicitis" and "appendicitis post blunt trauma" in PubMed, Google, and Medline yielded 23 full-text articles about traumatic appendicitis. The articles reported on acute post-traumatic appendicitis. Nevertheless, the relationship between acute appendicitis and trauma is still controversial. A few theories have attempted to explain the relationship; however, a definitive cause has not yet been identified. A patient presenting with right iliac fossa or diffuse abdominal pain after a traumatic event should be investigated, and acute appendicitis should be included in a differential diagnosis.

Keywords: Appendicitis, fairy tale, worldwide

Introduction
Acute appendicitis is the most common surgical condition in patients presenting to emergency departments worldwide. The mechanisms behind acute appendicitis have been explained by obstructions of the appendix lumen by fecaliths or foreign bodies [1, 2]. It was only in the early 1930s that the relationship between blunt trauma and acute appendicitis was reported [3, 4, 1]. The most famous figure who was speculated to have died from acute appendicitis after multiple blows to the abdomen was the magician Houdini in 1926 [2]. Whether acute appendicitis in a trauma setting is an incidental or casual finding is unclear. The aim of this literature review was to seek evidence about the possibility of the implementation of a traumatic appendicitis diagnosis.

Methods
Searches on the terms "traumatic appendicitis," "appendicitis post trauma," and "appendix injury" were performed in PubMed, Google, and Medline between August and October 2019. The inclusion criterion was full-text English-language articles. The exclusion criteria were articles with only abstracts or summaries. Twenty-three full-text published articles on traumatic or post-traumatic appendicitis were found.

Results
The total number of patients reported in the articles was 39: 36 males and 3 females [5, 6]. Each had been healthy prior to experiencing a traumatic event in the preceding 1–48 hours. Three cases were described as appendix injury or post-traumatic perforation [7-9]. One case was caused by a penetrating stab wound in the right lower abdomen [10]. The search results are summarized in Table 1. All the patients had been exposed to abdominal trauma, such as seat belt injuries, blows to the abdomen, assaults, and bicycle injuries. The age range was 5–65 years. The applied diagnostic modules were ultrasonography and computed tomography of the abdomen (Table 2). Some articles provided no documentation on the diagnostic modulates [1, 3, 5, 7]. One article did not specify the diagnostic investigations that were performed [5].
Fowler published a report on 48 cases that had been diagnosed as acute appendicitis caused by external trauma in industrial accidents; however, details were not provided [3]. He emphasized the lack of proper documentation of traumatic events and their times of occurrence.

This was attributed to the patients' manipulation of the period between trauma and injury to benefit from the compensation laws [3]. For linkage, most experts at that historical period set an interval of 48 hours between the clinical symptoms and the traumatic event [3]. A period of more than 48 hours between symptoms and a traumatic event would rule out a relationship [3]. Fowler stated that some cases were diagnosed intraoperatively as acute appendicitis; however, the results of histological examinations indicated otherwise [3].

Table 1: Searched articles with number of cases

Author	Publication year	Number of cases
Thomas [7]	1978	1
Hennington [1]	1990	2
Ciftci [6]	1996	5
Hagger [11]	2002	1
Ramesh [12]	2002	1
Karavokyros [13]	2004	1
Etensel [14]	2005	5
Toumi [15]	2010	1
Torres-Grau [16]	2012	1
Wani [5]	2013	8
Bouassria [10]	2013	1
Moslemi [8]	2013	1
Ahmed [17]	2014	1
Gupta [18]	2016	2
Seung [9]	2016	1
Jensen [19]	2016	1
Khilji [2]	2017	1
Siddiqui [4]	2018	1
Singh [20]	2018	1
AlJaberi [21]	2018	1
Çağlar [22]	2018	1
O'Kelly [23]	2019	1
		Total
		39

Table 2: Diagnostic investigations

Author	CT scan abdomen	Ultrasonography of the abdomen
Thomas [5]	Not done	Not done
Hennington [1]	Not done	Not done
Hennington [1]	Not done	Not done
Ciftci [6]	Not done	Not done
Ciftci [6]	Not done	Not done
Ciftci [6]	Not done	Not done
Ciftci [6]	Not done	Dilated bowel loops
Ciftci [6]	Not done	Dilated bowl loops
Hagger [11]	Dilated loops of small bowel, incarceration of edematous bowel in a right inguinal hernia, and edematous changes in the right perirenal tissues	Not done
Ramesh [12]	Not done	Bilateral iliac fossa fluid collection.
Karavokyros [13]	Not done	Free peritoneal fluid mainly around the liver
Etensel [14]	Not done	Large abdo fluid, hepatic lacerations
Etensel [14]	Not done	Large hepatic laceration, free fluid and retroperitoneal hematoma
Etensel [14]	Not done	Retroperitoneal hematoma
Etensel [14]	Free air	Free air
Etensel [14]	Splenic laceration, free fluid (large volume), pneumomediastinum, left hemidiaphragm and left ureteropelvic junction and urinoma	Not done
Toumi [15]	Appendicitis with an adjacent collection	Not done
Torres-Grau [16]	Not done	Normal liver, gallbladder, spleen and kidneys, with no evidence of presence of free fluids
Wani [5]	Used but no specifications	Used but no specifications
Wani [5]	Used but no specifications	Used but no specifications
Wani [5]	Used but no specifications	Used but no specifications
Wani [5]	Used but no specifications	Used but no specifications
Wani [5]	Used but no specifications	Used but no specifications
Wani [5]	Used but no specifications	Used but no specifications
Wani [5]	Used but no specifications	Used but no specifications
Wani [5]	Used but no specifications	Used but no specifications

Bouassria [10]	Not done	Normal
Moslemi [8]	Two small foci of air in the anterior aspect of the abdomen, in favor of pneumoperitoneum	Mild to moderate free fluid in the abdominopelvic cavity
Ahmed [17]	Not done	Fluid in the pelvis suggestive of hemoperitoneum
Gupta [18]	Not done	An appendicular lump with free fluid in the pelvis, without solid organ injury
Gupta [18]	Mild to moderate free fluid in the pelvis. No signs of pneumoperitoneum or solid organ injury.	Not mentioned
Seung [9]	Small amount of fluid collection in the pelvic cavity without pneumoperitoneum or extravasation of contrast	Small amount of fluid collection in the pelvic cavity
Jensen [19]	Demonstrated moderate stranding in the anterior abdomen and lower right quadrant.	Not done
Khilji [2]	8 mm thickening of appendix with minimal adjacent fat stranding	No free fluid in the abdominal cavity
Siddiqui [4]	Displayed an inflamed and distended distal appendix, the tip of which was located in the right upper quadrant	Not done
Singh [19]	Not done	Normal organ systems with minimal to mild ascites and low-level echoes
AlJaberi [20]	Minimal free fluid and a degree of inflammation of the appendix	Not done
Çağlar [21]	No vital organ injury, but inflamed acute appendix and minimal pelvic free fluid	Not done
O'Kelly [22]	Evidence of an inflammatory lesion in the right iliac fossa with evidence of hemoperitoneum	Not done

Table 3: Initial symptoms and time interval between trauma and symptoms

Author	Time interval between trauma and symptoms	Initial symptoms
Thomas [7]	4–6 hours	Tenderness in lower abdomen
Hennington [1]	1st case: 48 hours 2nd case: 12 hours	Severe pain in lower abdomen
Ciftci [6]	Not mentioned	Not mentioned
Hagger [11]	72 hours	Right lower quadrant pain; worse on movement
Ramesh [12]	48 hours	Persistent abdominal pain, nausea and vomiting
Karavokyros [13]	12 hours presumably	Vague abdominal pain and dysuria without concomitant diarrhea or vomiting
Etensel [14]	1st case: 4 hours 2nd case: 1 hour 3rd case: 1 hour 4th case: 1 hour 5th case: 15 mins	All with lower abdomen pain with or without abrasions
Toumi [15]	Immediately	Sever lower abdomen pain
Torres-Grau [16]	6 hours	Sever right sided abdominal pain
Wani [5]	24 hours–4 days	Lower abdomen pain
Bouassria [10]	24 hours	Right iliac fossa pain post stab
Moslemi [8]	6 hours	Diffuse abdominal pain with fever
Ahmed [17]	48 hours	Right lower abdominal pain
Gupta [18]	1st case: 96 hours 2nd case: 72 hours	Severe abdominal pain in both cases
Seung [9]	8 hours	Pain in the periumbilical area as well as the lower abdomen
Jensen [19]	6 hours	Acute abdominal pain and nausea
Khilji [2]	2 hours	Abdominal pain
Siddiqui [4]	1 hour	Right shoulder and lateral right hip
Singh [20]	48 hours	Abdominal pain
AlJaberi [21]	30 minutes	Right flank pain
Çağlar [22]	24 hours	Abdominal pain
O'Kelly [23]	24 hours	Sudden progressive right lower quadrant pain

Table 4: Trauma mechanisms, surgical intervention, intraoperative findings, and histology

Author	Mechanism of trauma	Procedure	Intra-operative findings	Histology
Thomas [5]	Low-velocity crush injury; patient was trapped between stationary and slow-moving vehicles	Open appendectomy via right paramedian incision	Torn mesoappendix: the appendix itself was completely severed at the junction of its proximal third and distal two-thirds	The appendix showed a small fecalith in the severed portion and mild but definite inflammatory changes confined to the mucosa of both portions.
Hennington [1]	Engine transmission (200 lb) fell on patient's abdomen	Open appendectomy	Gangrenous appendix	Not mentioned
Hennington [1]	Bicycle handlebar injury to his lower abdomen.	Open appendectomy	Acute suppurative appendicitis	Not mentioned

Ciftci [6]	RTA (pedestrian)	Open appendectomy	Perforated appendix	Appendicitis
Ciftci [6]	Fall	Open appendectomy	Acute appendicitis	Appendicitis
Ciftci [6]	Accident (ball)	Open appendectomy	Acute appendicitis	Appendicitis
Ciftci [6]	RTA	Open appendectomy	Perforated appendix	Appendicitis
Ciftci [6]	Assault	Open appendectomy	Acute appendicitis	Appendicitis
Hagger [11]	Patient fell from approximately 6 feet and landed prone on the rungs of the ladder	Open appendectomy	Gangrenous appendix with free pus	Not mentioned
Ramesh [12]	Bicycle handlebar injury to patient's lower abdomen.	Laparotomy with appendectomy	Pus in the abdomen and a perforated appendix	Not mentioned
Karavokyros [13]	Assault (blunt abdominal trauma)	Laparotomy with appendectomy	Inflamed appendix, a few enlarged mesenteric lymph nodes and free peritoneal fluid	Confirmed appendicitis
Etensel [14]	RTA	Laparotomy + appendectomy	Hepatic lacerations + appendicitis	Confirmed appendicitis
Etensel [14]	RTA	Laparotomy + appendectomy	Hyperemic, edematous, thickened appendix	Confirmed appendicitis
Etensel [14]	RTA	Laparotomy + appendectomy	Hyperemic, inflamed appendix	Confirmed appendicitis
Etensel [14]	Fall	Laparotomy + appendectomy	Hyperemic, edematous, thickened appendix	Confirmed appendicitis
Etensel [14]	RTA (pedestrian)	Laparotomy + appendectomy	Hyperemic, edematous, thickened appendix	Confirmed appendicitis
Toumi [15]	Fall and blow to abdomen	Open appendectomy	retrocecal appendix was grossly inflamed and necrotic	Acute suppurative appendicitis with serositis
Torres-Grau [16]	Fall from 2 meters	Laparoscopy + appendectomy	Necrotic, non-perforated appendix	Confirmed appendicitis
Wani [5]	Fall	Open appendectomy	Features of appendicitis	Confirmed appendicitis
Wani [5]	Fall	Open appendectomy	Features of appendicitis	Confirmed appendicitis
Wani [5]	Fall	Open appendectomy	Features of appendicitis	Confirmed appendicitis
Wani [5]	Kicked in the abdomen	Open appendectomy	Features of appendicitis	Confirmed appendicitis
Wani [5]	Kicked in the abdomen	Open appendectomy	Features of appendicitis	Confirmed appendicitis
Wani [5]	Kicked in the abdomen	Open appendectomy	Features of appendicitis	Confirmed appendicitis
Wani [5]	Kicked in the abdomen	Open appendectomy	Features of appendicitis	Confirmed appendicitis
Wani [5]	Compression on the right lower abdomen by a bicycle handlebar	Open appendectomy	Features of appendicitis	Confirmed appendicitis
Bouassria [10]	Penetrating stab wound to the abdomen	Laparotomy + appendectomy	Appendix was hyperemic and edematous	Confirmed diagnosis of acute appendicitis
Moslemi [8]	Bicycle handlebar injury to the lower abdomen	Exploratory laparotomy + appendectomy	Transection of the appendix from its distal half	Acute appendicitis
Ahmed [17]	Blunt trauma to the right lower abdomen from a desk corner	Exploratory laparotomy + appendectomy	Perforated appendix	Acute appendicitis
Gupta [18]	Bicycle handlebar injury	Open appendectomy	Appendix was perforated and fecalith	Appendicitis with appendicolith
Gupta [18]	Fall	Exploratory laparotomy + appendectomy	Appendicular lump with a perforated appendix	Perforated appendix with inflammation involving all layers of the appendix
Seung [9]	Motor vehicle collision	Exploratory laparotomy + appendectomy	Appendix was transected completely at its proximal portion, and the free distal portion of the transected appendix was found in the pelvic cavity (Fig. 4)	Not mentioned
Jensen [19]	Bicycle handlebar injury	Diagnostic laparoscopy + appendectomy	Appendix was traumatically amputated 1.5 cm above the base	Confirmed ruptured appendix
Siddiqui [4]	Fall from a ladder	Diagnostic laparoscopy + appendectomy	Inflamed retrocecal appendix consistent with acute appendicitis	Active inflammatory changes consistent with acute appendicitis
Singh [19]	Bicycle handlebar injury	Exploratory Laparotomy + appendectomy + perforation repair	Jejunal perforation with appendicitis	Acute appendicitis
AlJaberi [20]	Motor vehicle collision	Lower midline	Free fluid in the abdomen; a	Not mentioned

		exploratory laparotomy	completely transected appendix	
Çağlar [21]	Fall from a swing	Not mentioned	Inflamed and perforated appendix	Acute appendicitis
O'Kelly [22]	Kick to the abdomen during a soccer game	Lower midline exploratory laparotomy	Disintegrated perforated appendix	Evidence of a dense inflammatory infiltrate and necrotic fragments

RTA: Road Traffic Accident

Discussion

Traumatic appendicitis and post-traumatic appendicitis are controversial terms. Fowler [3] listed three criteria for using the term traumatic appendicitis: (1) The patient should be previously healthy with no history of pain attacks prior to the trauma; (2) the force of the trauma should be directed to the abdomen; and (3) the effects of the trauma must progress to appendicitis symptoms, such as pain. The time interval between the trauma and presenting symptoms is 1–72 hours [6, 11-14]. All the cases presented with diffuse abdominal or right iliac fossa pain [5, 14, 15, 22].

The pathophysiological mechanism is still unclear. Several theories have been formulated; however, a definitive cause has not been found. Hennington proposed that trauma that indirectly causes cecum contusion, mesenteric disruption, and enlarged lymph nodes could lead to the obstruction of appendiceal lumen, and this could lead to bacterial infection [1]. The bacterial infection would lead to the cycle, which eventually could lead to perforation [1]. A second theory has suggested that the position of the appendix could be a cause of traumatic appendicitis [15]. Post-traumatic appendicitis is unlikely to develop in a retrocecal appendix because of the protection from the cecum against the increased intra-abdominal pressure caused by trauma. However, it is more likely to occur in a pelvic appendix or appendix in the inguinal hernia (Amyand's hernia) [15]. A third theory has posited that the sudden increase of intra-abdominal pressure on the appendix could lead to inflammation, edema, and lumen obstruction [20]. A fourth theory is that the combination of appendicular fecalith and cecum trauma could cause an appendix lumen obstruction and infection [20].

Appendiceal transections have been reported after seat belt injuries and bicycle handlebar injuries to the abdomen [8, 9, 19, 21]. In these cases, a transection of the appendix was identified intraoperatively [8, 9, 19, 21]. The causes were crush or deceleration injuries [8, 9]. In one case, acute appendicitis was reported after a penetrating abdominal stab wound [10]. A right paracolic retroperitoneal hematoma was found with cecal and appendiceal wall hematomas intraoperatively. This might have led to compression on the cecum and appendix and the subsequent obstruction of the appendix lumen [10].

Blunt abdominal trauma from handlebar injuries or kicks directly in the abdomen in children should raise the index of suspicion of possible internal organ injury [12]. Abdominal ultrasonography could assist in the diagnosis of appendicitis in children [12]. In adults for whom traumatic appendicitis might be caused by seat belt trauma, road traffic accidents (including those involving motor vehicles), assaults, or falls from ladders [11, 9, 5, 14, 16, 15], abdominal ultrasonography and computed tomography of the abdomen are helpful tools in diagnostic confirmation [2].

Conclusion

Acute appendicitis after abdominal trauma is rare and controversial. Several theories have attempted to explain the relationship between trauma and appendicitis; however, no definitive cause has been found. For abdominal pain presentation after trauma, emergency physicians should consider appendicitis in the differential diagnosis.

Conflicts of interest

The authors have no conflicts to declare.

Sources of funding

There was no source of funding.

References

1. Hennington MH, Ellis J, Tinsley A, Herbert CCB, Proctor J. Acute Appendicitis Following Blunt Abdominal Trauma: incidence or Coincidence? Annals of Surgery. 1990; 214:61-63.
2. Khilji MF, Ullah QZ. Case Report Seat Belt Compression Appendicitis Following Motor Vehicle Collision. Case Reports in Emergency Medicine, 2017, 3-5.
3. Fowler RH. The Rare Incidence of Acute Appendicitis Resulting from External Trauma. Annals of Surgery. 1938; 107(4):529-539.
4. Siddiqui J, Oliphant R, Yeh ZY, Suen M. Appendicitis: A Traumatic Etiology. Journal of Case Reports. 2018; 8(3):176-178.
5. Wani I. Post-Traumatic Retrocaecal Appendicitis. OA Case Reports. 2013; 2(4):31.
6. Ciftci AHAO, Tanyel FC, Büyükpamukçu N. Appendicitis after Blunt Abdominal Trauma: Cause or Coincidence? European Journal of Pediatric Surgery. 1996; 6(6):350-353.
7. Thomas DFM. Injury to the Appendix after Blunt Abdominal Trauma. The British Medical Journal. 1978.
8. Moslemi S, Reza H. Co-Incidence of Acute Appendicitis and Appendiceal Transection after Blunt Abdominal Trauma: A Case Report. 2013; 38(4):343-346.
9. Go SJ, Sul YH, Ye JB, Kim JS. Appendiceal Transection Associated with Seat Belt Restraint. Annals of Surgery Treatment and Research. 2016; 91(2):93-95.
10. Bouassria A, Majdoub KI, Yazough I, Ousadden A, Mazaz K. Traumatic Appendicitis: A Case Report and Literature Review. World Journal of Emergency Surgery. 2013; 8:31.
11. Hagger SSR, Constantinou J. Acute Appendicitis After a Fall from a Ladder: A Traumatic Aetiology. Emergency Medical Journal. 2002; 19:366-367.
12. Ramesh TJG, Who P, Lng K. Appendicitis Following Blunt Abdominal Trauma. Medical Journal of Malaysia. 2002; 57(1):123-124.
13. Karavokyros I, Pikoulis E, Karamanakos P. A Case of Blunt Abdominal Trauma and Posttraumatic Acute Appendicitis. Turkish Journal of Trauma and Emergency Surgery. 2004; 10(1):60-62.
14. Etensel MEB, Yazıcı M, Gürsoy H, Özkısacık S. The Effect of Blunt Abdominal Trauma on Appendix Vermiformis. Emergency Medicine Journal. 2005; 22:874-877.
15. Toumi Z, Chan A, Hadfield MB, Hulton NR. Systematic Review of Blunt Abdominal Trauma as a Cause of Acute Appendicitis. Annals of the Royal College of Surgeons in England. 2010; 92:477-482.

16. Torres-Grau J, Monkhouse SJW. Trauma Induced Appendicitis … A Real Entity Torres. Am. Med. J. 2012; 3(2):124-125.
17. Ahmed ST, Ranjan R, Saha SB, Singh B. Traumatic Appendicitis Misdiagnosed as a Case of Haemoperitoneum, 2014, 2013-2015.
18. Gupta R, Mathur V, Bansal J, Bhandari A. Acute Appendicitis Following Blunt Abdominal Trauma in Children: By Chance or A Cause ? Formosan Journal of Surgery, 2016, 1-6.
19. Jensen A, Baertschiger R, Hackworth J, Rescorla F. Blunt Abdominal Trauma with Handlebar Injury: A Rare Cause of Traumatic Amputation of the Appendix Associated with Acute Appendicitis. Journal of Pediatric Surgery Case Reports. 2016; 7:13-15.
20. Aditya Pratap Singh RP, Gupta Arun Kumar, Barolia DK. Blunt Trauma Abdomen-Induced Jejunal Perforation with Appendicitis. Medical Journal of Dr. D. Y. Patil Vidyapeeth. 2018; 11:371-373.
21. Aljaberi LM, Eddin A, Salameh K, Almarzooqi RM, Emar MF. Transection of the Appendix and Omentum Following a Seat Belt Injury: Case Report and Literature Review. Annals of Medicine and Surgery. 2018; 34:11-13.
22. Aykut Çağlar HA, Er, Anıl Atacan, Özge Gülcü, Pelin Genç, Sinan Çağlar İlknur, Çelik Tanju. A Child with Acute Appendicitis Secondary to Blunt Abdominal Trauma: A Case Report and Review of the Literature. Journal of Pediatric Emergency and Intensive Care Medicine. 2018; 5:140-143.
23. O'Kelly JRF, Lim KT, Hayes B, Shields W, Ravi N. The Houdini Effect—An Unusual Case of Blunt Abdominal Trauma Resulting in Perforative Appendicitis. Irish Medical Journal. 2019; 105(3):86-87.