Re-emphasis on Imaging of Acute Abdomen in Surgical and Gynaecological Practice with Pictorial Depictions: A Review

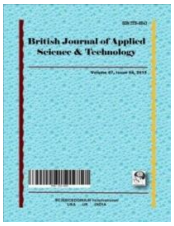
Article *in* British Journal of Applied Science and Technology · January 2015

DOI: 10.9734/BJAST/2015/13288

6 authors, including:

Felix Uduma
University of Uyo
38 PUBLICATIONS **27** CITATIONS
SEE PROFILE

Aisha Umar
National Hospital Abuja
3 PUBLICATIONS **0** CITATIONS
SEE PROFILE



British Journal of Applied Science & Technology
8(1): 1-9, 2015, Article no.BJAST.2015.181
ISSN: 2231-0843

SCIENCEDOMAIN *international*
www.sciencedomain.org

Re-emphasis on Imaging of Acute Abdomen in Surgical and Gynaecological Practice with Pictorial Depictions: A Review

Felix U. Uduma[1*], Teddy E. Ezirim[2], Itanyi Ukamaka[3], Isaac Udoh[4], Catherine Eyo[5] and Umar Aisha[6]

[1]Department of Radiology, Faculty of Clinical Sciences, College of Health Sciences, University of Uyo, Uyo, Nigeria.
[2]Department of Obstetrics and Gynaecology, Abia State University, Teaching Hospital, Aba, Nigeria.
[3]Department of Radiology, University of Abuja, Teaching Hospital, Abuja, Nigeria.
[4]Department of Surgery, Faculty of Clinical Sciences, College of Health Sciences, University of Uyo, Uyo, Nigeria.
[5]Department of Anaesthesiology, Faculty of Clinical Sciences, College of Health Sciences, University of Uyo, Uyo, Nigeria.
[6]Department of Radiology, National Hospital, Abuja, Nigeria.

Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/BJAST/2015/13288
Editor(s):
(1) Anonymous.
(2) Chandra R. Makanjee, School of Health Care Sciences, University of Pretoria, South Africa.
(3) Ming-Chih Shih, Department of Health and Nutrition Science, Chinese Culture University, Taiwan.
(4) Harry E. Ruda, Stan Meek Chair Professor in Nanotechnology, University of Toronto, Director, Centre for Advanced Nanotechnology, University of Toronto, Canada.
Reviewers:
(1) Sefu Juma Uledi, Department of Surgery, Mzuzu Central Hospital, Malawi.
(2) Anonymous, USA.
(3) Francisco Abaete Chagas-Neto, Radiology Department, Christus University Center, Brazil.
Complete Peer review History: http://www.sciencedomain.org/review-history.php?iid=1069&id=5&aid=8535

Review Article

Received 12th August 2014
Accepted 29th November 2014
Published 20th March 2015

ABSTRACT

Acute abdomen is a clinical emergency with core symptomatology of acute abdominal pain and hallmark requisite of speedy intervention. There are myriads of aetio-genesis that are basically multi-disciplinary.
Radiological imaging complements clinical examinations to arrive at meaningful diagnosis.

**Corresponding author: E-mail: felixuduma@yahoo.com;*

Sometimes imaging becomes the major diagnostic alternative to the encumbrances of palpating a tender, rigid abdomen.
Regrettably, despite the exploits of imaging, decision making process in some cases of acute abdomen could still be a major challenge, as no specific diagnosis may be made in these peculiar cases.
Some common cases seen in our various practice are depicted pictorially in this text to drive home some essential points of acute abdomen.

Keywords: Acute abdomen; pain; emergency; ultrasonography; computed tomography; coventional radiography.

1. OBJECTIVES

After reading this review article, the clinician will be able to:

- Recapitulate the principal causes of acute abdomen
- Have an insight into the radiological algorithm in assessing a patient with acute abdomen.
- Get a grasp of the indications, roles and limitations of each imaging modality.
- Identify salient radiological features of some of the common causes of acute abdomen as presented pictorially in this article.

2. BACKGROUND

The term 'acute abdomen' is a clinical condition that requires an emergent medical or more often surgical management [1]. It is a terminology that is widely used but poorly defined. A patient who becomes acutely ill with symptoms and signs principally tied to the abdomen, is said to have acute abdomen [2]. It is a life-threatening emergency that is of immense concern to any attending physician as time is of essence. Moreover, the patient is in severe abdominal distress that will warrant first priority attention.

3. EPIDERMIOLOGY

Acute abdomen is among the top three reasons why patients visit the emergency department or the urgent care centre of a hospital [3-6]. The four most common causes of acute abdominal pain that will require surgery are acute appendicitis, acute cholecystitis, small bowel obstruction and gynecologic disorders [4]. But when gynaecological disorders are excluded, acute appendicitis and acute non specific abdominal pain (NSAP), which ever order they come, become the most common causes of acute abdomen in most parts of the world [2]. NSAP is generally defined as acute abdominal pain of less than seven days duration with no diagnosis after examination and baseline investigations [5]. It is a major problem in general surgery accounting for an estimated 13% to 40% of emergency surgical admissions for acute abdominal pain [4,5]. In children however the commonest reason for emergent abdominal surgery is acute appendicitis [7].

4. AETIOLOGY

The etiology of acute abdomen ranges from relatively mild to life threatening pathologies, which may demand immediate surgery [2]. The plethora of aetiologies range from medical like gastroenteritis, surgical like appendicitis to gynaecological like ectopic pregnancy (Fig. 1). Gastrointestinal causes are acute appendicitis, acute cholecystitis, acute pancreatitis, peritonitis, acute intestinal obstructions like intussusceptions (Fig. 2), Others are volvolus, adhesions, perforated peptic ulcer, gastroenteritis, bowel perforations (typhoid, foreign body, tumour), acute diverticulitis and obstructed hernia (Fig. 3) [2,7]. Renal causes are nephrolithiasis (Fig. 4), renal colics, pyonephrosis, urinary tract infections and urinoma [8]. Gynaecological causes are ruptured ectopic pregnancy, ruptured simple ovarian cyst and ovarian torsion. Others are testicular torsion, pelvic inflammatory disease, pesticide ingestion (organophosphate poisoning) and visceral injury from trauma. Dissecting aortic aneurysm, NSAP, post-partum ovarian vein thrombosis, Henoch-Schönlein purpura (HSP), sickle cell crisis (from gut infarction or gallstone formation) and anisakidosis are further examples [2,4,7,9-15].

5. CLINICAL FEATURES

The hallmark of acute abdomen is the presence of abdominal pain [3,9]. This severe and sudden abdominal pain lasts over a short period (usually no longer than seven days) and often requires

surgical intervention [4,16]. Other accompanying symptoms to pain in acute abdomen are nausea, vomiting, or fever [17]. But acute abdominal pain and its accompaniment are however non-specific symptoms of many diseases [10]. For example, somatic pain and tenderness usually appreciated in the area two thirds of the distance from the umbilicus to the anterior superior iliac spine (McBurney point) are sensitive signs but not specific for appendicitis [7]. Furthermore, disease progression and patient pain response (from stoic to the hysterical) can confound diagnosis [7].

6. PAIN LOCALIZATIONS AND PAIN PATHOGENESIS

In terms of regional localization, there are three broad areas of association. Visceral pain in the lower esophagus, stomach and duodenum is perceived in the epigastric area while pain emanating from the small intestine is felt in the umbilical area [7]. Colonic visceral pain is felt in the lower abdomen [7]. Generally, abdominal pain are typically classified as visceral, somato-parietal, and referred pain [7]. Most abdominal pain is associated with visceral pain receptors [7]. Visceral pain receptors are located in the muscles and mucosa of hollow viscus, in the mesentery, and on serosal surfaces transmitted through the sympathetic, parasympathetic or somatic pathways [3,7]. These pain receptors typically respond to stretch. This occurs when the bowel is distended or mesentery is stretched or torsed [3,7]. Visceral pain response is usually not well localized [7]. This is because the afferent nerves associated with this pain are bilateral and have fewer nerve endings in the gut [7]. They are also unmyelinated and enter the spinal cord at several levels [7]. Increasing inflammation ultimately leads to somatic pain. This is via innermost parietal peritoneal irritation and transmitted through the segmental spinal nerves [3]. An example of a referred pain is Kehr's sign which is diaphragmatic pain from blood or pus under the diaphragm producing pain on top of the shoulder [3].

7. DIAGNOSIS

The diagnosis of acute abdomen is a critical challenge facing surgeons and this can be more difficult in special care patients [18]. The traditional careful history taking with emphasis on pain characteristics, gynecologic review combined with detailed physical examination assist to prune down the differential diagnoses. Despite the narrowing of differential diagnoses of acute abdomen using the aforesaid methods, radiological imaging remains indispensible in disease specificity. This ultimately guide any anticipated intervention.

8. DIAGNOSTIC DILEMMA

Acute abdomen is one condition with diagnostic dilemma. In establishing the diagnosis of acute abdomen, good history and physical examinations remain paramount as mentioned previously. Cardinal in the history is acute abdominal pain regardless of the cause [2]. In some cases, however, the pain may be a warning sign of something more sinister [8,17]. Like it could be an inflammatory cause (acute appendicitis), a chemical cause (peptic ulcer perforation with gastric contents inciting peritoneal infection or abscess) or mechanical (ileus or obstruction). It may also be neoplastic causes (tumor causing obstruction or impinging on nerves or vessels), vascular causes (superior mesenteric clot), congenital (esophageal atresia) or traumatic (major organ damage sustained in a motor vehicle accident) [4].

9. IMAGING ALGORITHMS

Since acute abdomen is a critical and emergency condition, precise diagnosis is pivotal to guide the pattern of management. Therefore choice(s) out of wide armamentarium of radiological investigations is mandatory to achieve this diagnosis. Unfortunately there is a trade-off based on cost, availability, sensitivity, specificity, accuracy and avoidable exposure to ionizing radiations. It is also known that the older the patient, the broader the differential diagnoses and greater opportunity to miss the diagnosis [3]. This could be fatal in acute abdomen. This therefore necessitates the employ of a diagnostic alternative that is superior to mere surgeons' palpations. Yes, nothing can replace the clinical acumen of the physician [1]. But the occult nature of diseases of acute abdomen and difficulties encountered in examining these patients due to severe abdominal pain, abdominal rigidity and guarding deter meaningful evaluation of the abdomen [10]. Several studies have demonstrated that a diagnosis based solely on a patient's medical history, physical examination, and laboratory tests is not reliable enough [10]. This is notwithstanding the fact that these aspects are essential parts of the workup of a patient presenting with acute abdominal pain [10]. For example, the typical signs of an acute

abdomen noted above like abdominal muscle rigidity, tenderness and peritoneal rebound are usually absent in those with a high spinal cord lesion [19].

The presentation of an 'acute abdomen' in spinal cord injured patients may understandably puzzle attending physicians and surgeons who will eventually resort to imaging [19]. Furthermore, right-sided pelvic pain is especially challenging and can be confusing because of the close proximity of the appendix, uterus, right fallopian tube, and right ovary [14].

Therefore decision making in patients with abdominal pain on the basis of clinical and laboratory evaluation alone can result in unnecessary interventions or delayed treatment of urgent conditions [5]. All these have prompted surgeons to look for more reliable diagnostic adjuncts for accurately diagnosing intra-abdominal pathology in order to avert negative surgeries [1]. In this respect, radiological imaging has become very handy.

Imaging has been shown to have a positive effect on the accuracy of clinical diagnosis [5]. Radiological multi-modalities commonly deployed in the diagnosis of acute abdomen are conventional radiography, computed radiography, ultrasonography, contrast radiography, computed tomography, magnetic resonance imaging (MRI) and nuclear medicine. First preference in the diagnostic algorithms depends on clinical suspicion, modality availability, cost, age of patient, modality invasiveness and locality of practice. The goal of imaging is to make the most accurate diagnosis using the least amount of radiation and cost. Ultrasonography is becoming the first choice request when considered across all disciplines including gynecological related acute abdomen [1,5,14]. It is an important diagnostic tool, particularly at the rural hospitals where facilities are inadequate [10]. Abdominal ultrasonography is regarded as a quick, repetitive, reliable, simple and cost-effective tool. It is also a bedside, non-invasive, non-ionizing and effective diagnostic tool for acute abdominal pain in emergency medicine. It has been found to confirm the primary diagnosis in 21-34% of patients and second / third differential diagnosis in further 12% of patients, when used alone as a diagnostic modality [1]. Ultrasonography adds more information to clinical examinations up to the tune of 40% and leads to a change in management in 20% of cases [10]. This management alterations lower not only the financial outlay but also the mortality and morbidity rates in these patients with acute abdomen who otherwise would have undergone unnecessary laparotomies [1]. The accuracy of ultrasonography has been found to be between 71–98% for biliary tract disease [10]. Abdominal ultrasonography has become a veritable tool in confirmation or exclusion of clinically suspected appendicitis, biliary tract disease, cholelithiasis (Fig. 5) aortic aneurysm, renal stones, ectopic cyesis, ileus, visceral trauma, hemorrhagic ovarian cysts, ovarian torsion and peritonitis [10,14]. Fifty-three percent of patients with ovarian torsion are known to have pre-existing ovarian cyst or mass [14]. Doppler ultrasonography has additional advantage of evaluating blood flow to some salvageable torsed testicle [7]. Separate studies have found ultrasonography to be 50% diagnostic in knowing the etiology of acute abdomen in children but this diagnostic accuracy decreases to 25-34.7% in adults [1]. This higher diagnostic yield in paediatric population is due to their thinner abdominal wall and use of higher frequency probes (>5 MHz) [1]. Ultrasonography is very accurate in detecting intussusceptions and is considered the test of choice [7].

Ultrasonography remains the first line of imaging in pregnant patients presenting with acute abdomen [20]. When the serum β-hCG level is greater than 1,500 IU per L (often referred to as the discriminatory zone), a gestational sac should be visible on ultrasonography; otherwise ectopic pregnancy should be suspected [14]. An intrauterine pregnancy can be distinguished from a pseudo-sac of an ectopic pregnancy by double echogenic rings (double decidual sac sign). A pseudo- sac is characterized by only a single echogenic ring [14].

However, ultrasonography is operator dependent and its sensitivity and specificity in the diagnosis of appendicitis is rather low [10]. However it offers patient triage or additional imaging [20].

Traditionally, imaging workup in most poor-resource centres starts with abdominal radiography despite its draw-backs. A plain radiograph may show a dilated stomach and proximal duodenum in small intestinal volvulus [7]. But the primary test for such volvulus is a contrast upper gastrointestinal study. An abdominal radiograph may show obstruction or an air bubble in the groin in incarcerated inguinal hernia [7] Conventional or computed radiography

has a high sensitivity and specificity in identifying pneumoperitonium (Fig. 6) Pneumoperitoneum could occur without any gastrointestinal tract perforation and this is seen in perforated pyometria, perforated liver abscess, and ruptured necrotic lesion of liver metastasis [21]. Plain radiograph of the abdomen has been used conventionally in the diagnostic workup of the children with acute abdomen however, its diagnostic yield is limited because of its high non-specificity and low sensitivity [1]. The same scenario is seen in adults [22].

Because of the diagnostic limitations of plain film of the abdomen, any cross-sectioning technique, such as computed tomography (CT) or ultrasonography, is likely to provide more and sometimes entirely different information about acute abdominal pathology [1].

Computed tomography (CT), since its advent has established its effectiveness as well as its efficacy in the diagnosis of certain acute abdominal conditions [1], CT and in particular CT` after negative ultrasonography, provides a better workup than plain abdominal radiography alone [22]. Appendicitis can be diagnosed by ultrasonography, with a sensitivity of 75 to 90 percent compared to 87 to 98 percent for CT [14]. When ultrasonography is indeterminate, CT should be considered [14]. A prospective study of 1,011 patients evaluated for urgent abdominal and pelvic pain found that ultrasonography, followed by CT for negative or inconclusive ultrasonography, resulted in the most sensitive strategy with the least amount of radiation exposure [14]. The benefits of CT lie in decision-making for management, planning of a surgical strategy, and even avoidance of negative laparotomies [22]. Ovarian vein thrombosis (OVT) is an unusual cause of acute abdomen but readily demonstrated with CT [23]. It is a rare but serious condition affecting mostly postpartum women. Patho-physiologically, OVT is due to Virchow's triad, because pregnancy is associated with a hyper-coagulable state, venous stasis due to compression of the inferior vena cava by the uterus and endothelial trauma during delivery or from local inflammation [23].

Wandering spleen is a congenital mal-development or acquired laxity of the splenorenal, gastrosplenic and splenocolic ligaments connecting the spleen with the surrounding tissues [24]. Wandering spleen can result in torsion of the spleen but this is a rare clinical entity [24]. This torsion may result in acute abdomen. CT facilitates the detection of torsed wandering spleen.

The major snag of CT is its high radiation dose and non- usefulness in pregnancy Abdominal or pelvic CT exposes a patient to a radiation dose equivalent to 200 chest plain radiographs [14]. Its utility in emergency setting is limited by immobility, occasional need for sedation in children and cost [24]. Though the accuracy of CT is superior to that of ultrasonography in the diagnosis of acute appendicitis but a CT-scan is rarely available at rural hospitals [10].

MRI is not a routine tool in the diagnosis of acute abdomen as it is time consuming, and costly. Costly examinations like CT and MRI are generally ordered for verification, but these additional tests change the final treatment plan in very few patients [10]. More over, patients' restlessness resulting from acute abdomen hampers acquisition of optimal MR images. However, MRI can be exploited in some cases like acute aortic syndrome and acute pancreatitis. The terminology acute aortic syndrome (AAS) incorporates aortic dissection, intramural haematoma, and penetrating atherosclerotic ulcer [25]. This is basically due to aortic wall tunica media disruption [25]. To avert fatality, a prompt, non-invasive tool with wide field of view like MRI should be used. Such MRI investigation permits assessment of morphology, function, risk stratification of patients with AAS, treatment strategy and complications [25].

The most common causes of acute pancreatitis are gallstones and alcohol abuse accounting for 60-80% of cases [26]. Complications of acute pancreatitis include fluid collections, pseudo-cyst formation, abscess, pancreatic necrosis, hemorrhage, venous thrombosis, and pseudoaneurysm formation [26]. The prefered examination technique for detection of acute pancreatitis and its complications is contrast-enhanced computed tomography (CECT) [26]. The usefulness of CECT is limited in patients who are allergic to intravenous contrast or have renal insufficiency. Patients who have severe acute pancreatitis often require multiple scans to assess progress and complications. This necessitates significant radiation doses. [26] Therefore, an adjunctive radiological tool with comparable diagnostic efficacy will be MRI.

10. TREATMENT

What is uppermost in acute abdomen is expedited intervention be it medical or surgical as prescribed by the implicated specific etiology.

11. COMPLICATION / OUTCOME

The outcomes of acute abdomen vary from remediable problem to a serious condition mandating surgery, posing a diagnostic Gordian knot [7]. For example, delay in surgical intervention in volvolus can cause short gut or death [7]. Likewise delay in diagnosis of acute pelvic pain leads to sequelae such as appendiceal perforation, ovarian torsion, and hemoperitoneum from an ectopic pregnancy [14]. However prompt diagnosis and management of certain acute abdominal cases have good prognosis like acute appendicitis, and ruptured ectopic pregnancy.

12. DIFFERENTIAL DIAGNOSES

Despite the advances in imaging modalities, diagnosis of acute abdomen is still doubtful in 30%-40% of cases [5]. Mimics of acute abdomen are diverse and any organ- system can be implicated as shown below.

Chest pathologies like pneumonias.
Neck pathologies - Streptococcal pharyngitis.
Metabolic-Diabetic ketoacidosis
Haematological -Sickle cell crisis.
Urogenital- complicated imperforate hymen, complicated transverse vaginal septum, corpus luteum haematoma in pregnancy, uterine impaction in first trimester, placenta abruptio, preterm labour in third trimester, post-natal endometritis, ovarian vein thrombosis.

Miscellaneous-Functional abdominal pains, malingering [7,14,27].

13. THE FOLLOWINGS ARE SOME OF THE COMMON EXAMPLES OF ACUTE ABDOMEN SEEN IN OUR DIFFERENT PRACTICES

Fig. 1. Abdominal echogram showing a right adnexal extra-uterine un-ruptured gestational sac harbouring a living embryo (see black arrow). Note adjacent small intra-peritoneal bleeds. Diagnosis was a leaking ectopic pregnancy

Fig. 2. Abdominal computed tomogram (reconstructed coronal image) showing empty right iliac fossa. Note the oral contrast opacified ileum that has invaginated into the caecum just beneath the liver (see white arrow). Diagnosis was Ileo-colic Intussusceptions

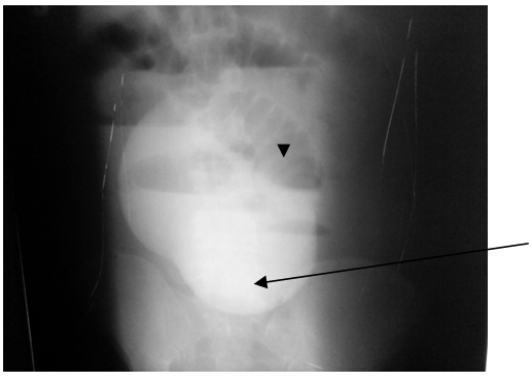


Fig. 3. Is a supine abdominal computed radiograph of a 36year old man with incarcerated umblical hernia (see black arrow). This was confirmed by lateral abdominal radiograph and abdominal ultrasonography which are not included here for brevity. Note dilated central loops of bowel with valvulae conniventes typical of small intestinal obstruction (see black arrow head)

Fig. 4. Abdominal echogram showing a 15 X 6 mm curvilinear, echogenic, shadowing intra-renal calculus (see black arrow). This calculus is located at posterior mid-polar region of right kidney approximating to the origin of the right renal pelvis. Diagnosis is right nephrolithiasis

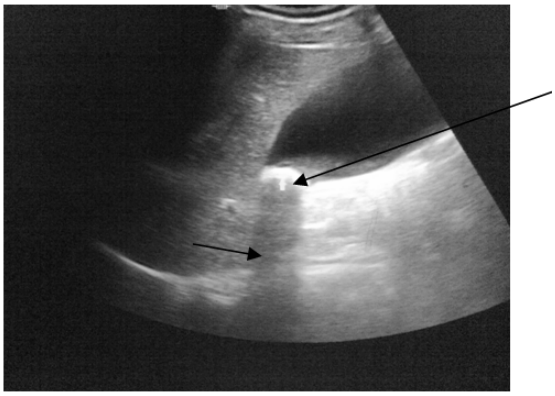


Fig. 5. Abdominal echogram showing an echogenic focus at the bladder neck (see long black arrow) with posterior acoustic shadowing (see short black arrow). Gall bladder wall was also thickened but devoid of peri-cholecystic collection. Diagnosis was cholelithiasis with cholecystitis

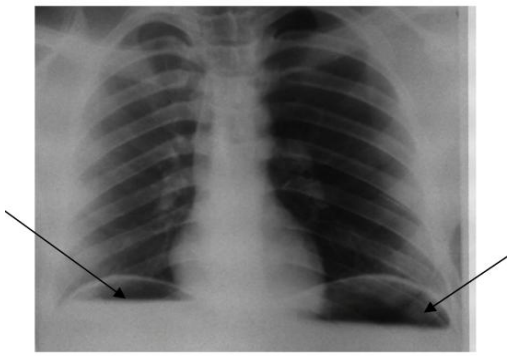


Fig. 6. Chest posterior anterior conventional radiograph showing gas beneath both hemi-diaphragms (see black arrows), typical of pneumo-peritonium

14. CONCLUSION

Acute abdomen is an emergency condition that requires urgent interventions. Despite the resourcefulness of clinical examinations by the attending physicians, radiological investigations are indispensible to avert negative sugeries. Therefore constantly reminding clinicians of how best to complement diagnosis using imaging tools to arrive at succinct diagnosis cannot be over-emphasized

15. RECOMMENDATIONS

Further assessment of cases of acute abdomen with radiological tools despite the exquisite skills of the hands of the clinicians in palpations should be encouraged.

In our resource poor environ, ultrasonography and/or conventional radiography of the abdomen should be quickly done since they are available and cheap. Computed tomography where available could be employed as an ancillary tool in acute abdomen since it is costly and accompanied by high radiation dose.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Chana RS, Ahmad I. Role of ultrasonography in the evaluation of children with acute abdomen in the emergency set-up. J Indian Assoc Pediatr Surg. 2005;10:41-3.
2. Debrah SA, Diallo A. Clinical spectrum of acute abdomen in cape coast. Webmed Central General Surgery. 2012;3(4): WMC003209.
   Bob Blumm. The acute abdomen- Part II: Information for Physician Assistants and Nurse Practitioners; 2010.
   Available:http://www.healthjobsnationwide.com/news/The-Acute-Abdomen-Part-II-Information-for-Physician-Assistants-and-Nurse-Practitioners/450.html (Accessed on 21/3/201114).
3. Amy- Wisniewsky A. Acute abdomen; Shaking down the suspects. Linppincort Nursing Centre.com. 2018;8(1):42-52. (Accessed on 2.4/2014).
4. Mayyas E, Ahmad S, Sbaihat AS, Khori F. Threatening signals in acute abdomen RMJ. 2010;35(2):160-164.
5. Yusuf A, Hakan D, Fatih AZ, Yasemin G, Yenerdo Ui. A rare etiology of acute abdomen syndrome: Gallbladder Torsion. Available:http://dx.doi.org/10.4021/jmc1293e (Accessed on 4/5/2014).
6. Ross A, LeLeiko NS. Acute Abdominal Pain. Pediatrics in Review 2010;31(4):135-144. Page 26. DOI: 10.1542/pir.31-4-135.
7. Pyrpasopoulou A, Georgopoulou VM, Anyfanti A, Soufleris K, Koumara H, Chatzimichailidou S, Simoulidou, et al. E, Spontaneous urinoma: An unexpected cause of acute abdomen. American Journal of Emergency Medicine. 2011;29 (6): 695.e3-695.
8. Arturo DR, Juan DF, Hermann OR, Manuel HJ, Javier F, Ricardo MM, Tani GQ, et al. Acute abdomen, anisakidosis and surgery: Value of history, physical examination and non immunological

diagnostic procedures. Journal of Medicine and Medical Sciences. 2013;4(2):63-70.

9. Exadaktylos AK, Sadowski-Cron C, Mäder P, Monika Weissman M, Hans P, Dinkel' HP, Negri M, et al. Decision making in patients with acute abdominal pain at a university and at a rural hospital: Does the value of abdominal sonography differ? World Journal of Emergency Surgery. 2008;3:29. DOI:10.1186/1749-7922-3-29.
10. Aslan S, Cakir Z, Emet M, Serinken M, Karcioglu O, Kandis H, Uzkeser M, et al. Acute abdomen associated with organophosphate poisoning. The Journal of Emergency Medicine. 2011;41(5):507-512. Page 27.
11. Supplement: The pediatric hospital medicine core competencies supplement acute abdominal pain and the acute abdomen. Journal of Hospital Medicine. 2010;5(Supplement S2):1–2.
DOI: 10.1002/jhm.720.
12. Hoxha FT, Hashani' ST, Komoni' DS, Gashi-Luci' LH, Kurshumliu FI, Hashimi MS, Krasniqi AS. Acute abdomen caused by ingested chicken wishbone: A case report. Journal of Medical Cases. 2009; 2:64. DOI:10.1186/1757-1626-2-64.
13. Kruszka PS, Kruszka SJ. Evaluation of acute pelvic pain in women. Am Fam Physician. 2010;82(2):141-147.
14. Mcrae FW. The acute surgical abdomen. Southern Medical Journal. 2005;8(4):293-295.
15. Matin MA, Siddiq AKMZ, Hasan MM. Acute abdomen in a peripheral military hospital. Journal of Armed Forces Medical College, Bangladesh. 2009;5 (2).
16. Zeller JL, Alison E. Burke AE, Richard M, Glass RM. Acute abdominal pain. JAMA. 2006;296(14):1800.
DOI:10.1001/jama.296.14.1800.
17. Siriwardena AK. Imaging in patients with acute abdominal pain. BMJ. 2009; 338:b1678. 2.
Available:http://www.bmj.com/rapid-response/2011/11/02/management-acute-abdominal-pain (Accessed on t/7/14).
18. Baron Z, Ohry A. The acute abdomen in spinal cord injury individuals. Paraplegia. 1995;33:704–706.
DOI:10.1038/sc.1995.148.
19. Glanc P, Maxwell C. Acute Abdomen in Pregnancy. Role of Sonography. JUM. 2010;29(10) :1457-1468.
20. Sahoo SP, Dora AK, Harika M, Kumar K R. Spontaneous uterine perforation due to pyometra presenting as acute abdomen. Indian J Surg. 2011;73(5).
21. Gans SL, Stoker J, Boermeester MA. Plain abdominal radiography in acute abdominal pain; past, present, and future. International Journal of General Medicine. 2012 ;5:525-533.
Available :http://dx.doi.org/10.2147/IJGM.S17410
22. Arkadopoulos N, Dellaporta D, Yiallouro UA, Koureas A, Dionysios Voros D. Ovarian vein thrombosis mimicking acute abdomen: A case report and literature review. World Journal of Emergency Surgery. 2011;6:45. DOI:10.1186/1749-7922-6-45.
23. Koca B, Çınar H, Tarım İA, Güngör BB. Torsion of the wandering spleen: A rare case of acute abdominal causing. Gulhane Med J. 2013;55(1):51-53.
24. Evangelista A, Carro A, Moral S, Teixido-Tura G, Rodríguez-Palomares JF, Cuéllar H, García-Dorado D. Imaging modalities for the early diagnosis of acute aortic syndrome. Nature Reviews Cardiology. 2013 ;10:477-486.
DOI:10.1038/nrcardio.2013.92.
25. Romero-Urquhart GL, Karani J. Acute Pancreatitis Imaging. Medscape; 2013. Available:http://emedicine.medscape.com/article/371613-overview (Accessed on 16/9/14).
26. Cartwright LS, Knudson MP. Evaluation of acute abdominal pain in adults. Am Fam Physician. 2008;77(7):971-978.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history.php?iid=1069&id=5&aid=8535