Hot Topics in Acute Care Sugery and Trauma

Fausto Catena
Salomone Di Saverio
Luca Ansaloni
Federico Coccolini
Massimo Sartelli *Editors*

CT Scan in Abdominal Emergency Surgery

Springer

Hot Topics in Acute Care Surgery and Trauma

This series covers the most debate dissues in acute care and trauma surgery, from perioperative management to organizational and health policy issues. Since 2011, the founder members ofthe World Society of Emergency Surgery's (WSES) Acute Care and Trauma Surgeons group, who endorse the series, realized the need to provide more educational tools for young surgeons in training and for general physicians and other specialists new to this discipline: WSES is currently developing a systematic scientific and educational program founded on evidence-based medicine and objective experience. Covering the complex management of acute trauma and non-trauma surgical patients, this series makes a significant contribution to this program and is a valuable resource for both trainees and practitioners in acute care surgery.

More information about this series at http://www.springer.com/series/15718

Fausto Catena • Salomone Di Saverio
Luca Ansaloni • Federico Coccolini
Massimo Sartelli
Editors

CT Scan in Abdominal Emergency Surgery

Springer

Editors
Fausto Catena
Emergency and Trauma Surgery
Ospedale Maggiore di Parma Emergency and Trauma Surgery
Parma, Parma, Italy

Luca Ansaloni
General, Emergency and Trauma Surgery
Department Bufalini Hospital
Cesena, Italy

Massimo Sartelli
Department of Surgery Macerata Hospital
Macerata, Italy

Salomone Di Saverio
Cambridge Colorectal Unit
Cambridge University Hospitals NHS Foundation Trust
Addenbrooke's Hospital
Cambridge, UK

Federico Coccolini
General, Emergency and Trauma Surgery
Department
Bufalini Hospital
Cesena, Italy

ISSN 2520-8284 ISSN 2520-8292 (electronic)
Hot Topics in Acute Care Surgery and Trauma
ISBN 978-3-319-48346-7 ISBN 978-3-319-48347-4 (eBook)
https://doi.org/10.1007/978-3-319-48347-4

Library of Congress Control Number: 2017960211

Printed on acid-free paper

This Springer imprint is published by the registered company Springer International Publishing AG part of Springer Nature
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

To my wife Rita and to my sons Guglielmo and Lodovico for the time stolen from them and devoted to work

Foreword to the Series

Since 2011, the founding members of the World Society of Emergency Surgery's (WSES) Acute Care and Trauma Surgeons group, in collaboration with the American Association for the Surgery for Trauma (AAST), endorse the development and publication of the "Hot Topics in Acute Care Surgery and Trauma," realizing the need to provide more educational tools for young surgeons in training and for general physicians and other surgical specialists new to this discipline. These new forthcoming titles have been selected and prepared with this philosophy in mind. In particular, *CT Scan in Abdominal Emergency Surgery* focuses on the diagnostic impact of CT scans in severe abdominal trauma and in nontraumatic acute abdomen, the two clinical entities that constitute the main reasons for referrals to this imaging technique in emergency. The concept behind this practical book is that emergency surgeons and physicians not only need the clinical knowledge to manage the different acute pathological conditions but they must also have a full understanding of diagnostic imaging modalities. Each chapter includes a description of a specific acute abdominal disorder: in addition to the clinical presentation and to the diagnosis and management guidelines, the readers will find a special focus on imaging studies with clear and concise descriptions. This book is a useful tool to achieve a strong background to understand CT scans and to perform right diagnosis with proper conservative or surgical treatments.

Cesena, Italy — Federico Coccolini
Riverside, CA — Raul Coimbra
Calgary, AB, Canada — Andrew W. Kirkpatrick
Cambridge, UK — Salomone Di Saverio

Preface

In the past era, the science of emergency surgery was a completely different one without CT scans. We used to perform a good number of diagnostic laparotomies, and plain abdomen X-ray was the most used diagnostic test. Nowadays, plain abdomen X-ray is seldom used, and diagnostic laparoscopy has taken the place of diagnostic laparotomy.

CT scan is the "king" of emergency surgery diagnosis and the only barrier between clinical examination and diagnostic laparoscopy—as a matter of fact, CT scan is the fundamental tool in emergency surgery. According to the WSES Guidelines, CT scan is the test with the highest sensitivity and specificity in intra-abdominal infections. It is therefore mandatory for any surgeon/physician dealing with emergency surgery patients to have a specific expertise to read CT images.

This book focuses on the diagnostic impact of CT scans in severe abdominal trauma and in nontraumatic acute abdomen, the two clinical entities that constitute the main reasons for referrals to this imaging technique in emergency. The concept behind this practical book is that emergency surgeons and physicians not only need the clinical knowledge to manage the different acute pathological conditions but they must also have a full understanding of diagnostic imaging modalities.

To this end, each chapter includes a description of a specific acute abdominal disorder: in addition to the clinical presentation and to the diagnosis and management guidelines, the readers will find a special focus on imaging studies with clear and concise descriptions. Evolution and grading scales will also be included for the interpretation and high-quality images.

This easy-to-read book is not only an ideal source of practical information for acute care surgeons, radiologists, physicians, and for all the members of the emergency team, but also a useful tool to understand CT scans and to perform right diagnosis with proper conservative or surgical treatments.

Enjoy the reading …

Parma, Italy — Fausto Catena
Cambridge, UK — Salomone Di Saverio
Cesena, Italy — Luca Ansaloni
Cesena, Italy — Federico Coccolini
Macerata, Italy — Massimo Sartelli

Contents

Diagnostic Tools in ACS: CT Scan, Diagnostic Laparoscopy, and Exploratory Laparotomy

1

Ning Lu and Walter L. Biffl

1.1 Introduction

The abdomen is a black box of diagnostic uncertainty. There is an old surgical adage that goes "never let the skin come between you and the diagnosis." However, it is just that: an old adage. The surgeon has many alternatives to employ in situations in which the clinical diagnoses, or decision to operate, are not straightforward. In this chapter, three primary modalities are discussed: computed tomography (CT) scanning, diagnostic laparoscopy (DL), and exploratory laparotomy (LAP).

1.2 CT Scanning

The CT scan is an exceedingly valuable tool for the diagnosis of essentially any abdominal surgical problem. A CT scan can quickly and accurately demonstrate any number of pathologies while ruling out others, allowing the surgeon to narrow the list of differential diagnoses and plan definitive management strategies. It is noninvasive, rapid, and nearly universally available and has been insinuated into myriad clinical care guidelines for surgical problems. The ability to grade the severity of pathology prior to operating allows the surgeon to tailor the approach to the situation and to counsel the patient regarding expectations more accurately.

N. Lu, M.D.
Hawaii Residency Program in General Surgery, Honolulu, HI, USA

W.L. Biffl, M.D. (✉)
Acute Care Surgery, The Queen's Medical Center, Honolulu, HI, USA

Department of Surgery, John A. Burns School of Medicine, University of Hawaii—Manoa, Honolulu, HI, USA
e-mail: walt@biffl.com

F. Catena et al. (eds.), *CT Scan in Abdominal Emergency Surgery*, Hot Topics in Acute Care Surgery and Trauma, https://doi.org/10.1007/978-3-319-48347-4_1

1.2.1 Perforated Gastroduodenal Ulcers

CT is 95% sensitive and 93% specific for diagnosing gastroduodenal perforation. In addition to identifying free air, signs of peri-duodenal fat stranding, wall defect/ulcer, and wall thickening can be seen 72–89% of the time [1]. However, these other signs may not be visible before at least 6 h of symptomatology [2].

1.2.2 Cholecystitis

Ultrasonography is the accepted standard for detecting cholelithiasis and diagnosing acute calculous cholecystitis. CT can detect gallstones only 50% of the time, but in patients with equivocal ultrasounds, CT can demonstrate wall thickening, pericholecystic stranding, and pericholecystic fluid [3–5]. CT is also valuable in identifying complications of cholecystitis, including emphysematous, hemorrhagic, or perforated cholecystitis [6].

1.2.3 Choledocholithiasis

CT has a diagnostic sensitivity ranging from 56.5 to 81% and a specificity ranging from 72.8% to 96%. Thus, it is not the initial imaging study of choice for patients suspected of choledocholithiasis [7, 8]. On the other hand, CT can accurately and reliably identify common bile duct dilation.

1.2.4 Pancreatitis

CT has a 92% sensitivity and 100% specificity in identifying acute pancreatitis. It is 80–90% accurate with a 90% sensitivity and 33% specificity in identifying pancreatic necrosis [9–11]. In addition, CT imaging allows classification of pancreatitis per Atlanta and revised Atlanta Classification [12, 13].

1.2.5 Small Bowel Obstruction

CT is able to diagnose complete bowel obstruction with a sensitivity of 92% (81–100%) and a specificity of 93% (68–100%). CT is able to diagnose intestinal ischemia with 83% (63–100%) sensitivity and 92% (61–100%) specificity [14, 15]. CT has great value in patients with inconclusive plain films and can be helpful in determining the likely etiology of the obstruction, whether it is due to hernias, adhesions, or malignancy [16].

1.2.6 Mesenteric Ischemia

CT angiography is rapid and noninvasive for diagnosis of acute mesenteric ischemia and its multiple etiologies (arterial thrombosis, arterial embolism, mesenteric vein thrombosis, and nonocclusive ischemia), with a sensitivity and specificity of 96% and 94%, respectively [17]. CT angiography in nonocclusive mesenteric ischemia will demonstrate no signs of arterial or venous occlusion, may demonstrate vascular spasm, and may demonstrate more diffuse nonconsecutive segments of bowel with signs of ischemia. However, after ruling out vascular occlusive disease, diagnosing nonocclusive mesenteric ischemia still requires a high clinical suspicion [18]. The ability to differentiate the multiple etiologies of mesenteric ischemia is critical as the treatment for each can vary.

1.2.7 Appendicitis

CT is 91% sensitive and 90% specific for diagnosing acute appendicitis. For those suspected of having appendicitis, there is clear benefit to the use of IV, but not oral contrast [19]. In addition, CT can grade the severity of appendicitis (inflamed, perforated with localized free fluid, perforated with regional abscess, perforated with diffuse peritonitis) [20]. The grading of appendicitis can allow for appropriate treatment plans, which may be operative or via IR drainage.

1.2.7.1 Diverticulitis

CT is 94% sensitive and 99% specific in the diagnosis of acute diverticulitis [21]. In addition to identifying the absence or presence of perforation, CT allows for Hinchey classification of perforated diverticulitis. This facilitates determination of whether hospitalization is required and selection of patients for medical vs. surgical therapy [22] (Table 1.1).

Table 1.1 Summary of CT in diagnosing intra-abdominal pathologies

Pathology	Sensitivity	Specificity	Grading/classification capability
Perforated gastroduodenal ulcers	95%	93%	
Cholecystitis	–	–	
Choledocholithiasis	56.5–81%	72.8–96%	
Pancreatitis	92%	100%	X
Pancreatic necrosis	90%	33%	
Small bowel obstruction	92% (81–100%)	93% (68–100%)	
Intestinal ischemia	83% (63–100%)	92% (61–100%)	
Mesenteric ischemia	96%	94%	X
Appendicitis	91%	90%	X
Diverticulitis	94%	99%	X

CT is, of course, not without risks. The average CT abdomen/pelvis with contrast has an estimated radiation dose of 10–30 and 3–10 mSv in pediatric patients. The average CT angiogram of the abdomen has an estimated radiation dose of 1–10 and 0.3–3 mSv in pediatric patients. When possible, the risks of radiation exposure are minimized in the pregnant and pediatric populations. Depending on the pathology, ultrasound and MRI are viable options with similar accuracy. In the pediatric population, ultrasound approaches the accuracy of CT in diagnosing appendicitis with a sensitivity of 88% and specificity of 94% [23]. In the pregnant population suspected of appendicitis, MRI has a sensitivity of 97% and specificity of 95% [24].

Most non-trauma patients are candidates for CT for diagnosis. It is not recommended for patients who are unstable and in extremis. For those with renal dysfunction, exposure to contrast agents should be minimized. There is a well-known risk of contrast-induced nephropathy.

1.3 Diagnostic Laparoscopy

Laparoscopy is increasingly used in the diagnosis and treatment of many intra-abdominal pathologies. Traditionally, patients admitted with acute abdominal pain of unclear origin are managed with observation (serial abdominal exams, laboratory tests, and/or repeat imaging), progressing to surgery only if signs of peritonitis develop. However, this can lead to delays in diagnosis. In certain populations (immunocompromised, morbidly obese, paraplegic/quadriplegic, sedated, comatose), the abdominal exam is not always reliable. In patients with a suspected acute abdomen or unexplained unrelenting acute abdominal pain, especially those with an unreliable exam, diagnostic laparoscopy may be invaluable. The diagnostic accuracy of laparoscopy is 90%–99.5% [25–30].

After a diagnosis is made, treatment can also be achieved laparoscopically in many instances with safety and efficacy. By avoiding laparotomy, the relatively higher morbidity can be avoided as well. In cases of acute cholecystitis and acute appendicitis, laparoscopic cholecystectomy and appendectomy are safe and effective, now becoming the standard of care (level I). For patients with Hinchey I–IV perforated diverticulitis, when colectomy is performed, laparoscopic colectomy (with or without Hartmann's procedure) has been performed successfully by expert laparoscopic groups. For patients with Hinchey III perforated diverticulitis, laparoscopic exploration with peritoneal lavage and drainage is an emerging therapeutic modality. Current recommendation for laparoscopic management of diverticulitis is level 3. For gastroduodenal perforations, laparoscopic management has been demonstrated to be safe and effective (level 1) [31]. In the case of adhesive small bowel obstruction, laparoscopy is an emerging therapy, which may be successful in hands of an experienced laparoscopic surgeon on a hemodynamically stable patient, in the absence of peritonitis or severe intra-abdominal sepsis, in patients with localized distension on imaging, in the absence of severe abdominal distention, in an anticipated single band, and in a low peritoneal adhesion index. The etiology of the obstruction can be determined with 96.9% accuracy, and treatment can be provided

without conversion to laparotomy in more than 50% of patients [16, 32, 33]. Minimally invasive necrosectomy is an emerging therapeutic option with less morbidity and mortality than open necrosectomy in the hands of experienced laparoscopic surgeons [34, 35].

Laparoscopy is contraindicated with patients known to have a "frozen abdomen," massive bowel distention, inability to tolerate pneumoperitoneum, uncorrectable coagulopathy, uncorrectable hypercapnia >50 torr, or hemodynamic instability [36]. Historically, laparoscopy was delayed until the second trimester to reduce the likelihood of complications including spontaneous abortions and preterm labor. However, recent studies show that it may be safe to perform laparoscopy during any trimester of pregnancy without increased risk to the mother or fetus. However, data on long-term effects to children is lacking [37].

Given the safety, efficacy, and accuracy of diagnostic laparoscopy, with the added ability to treat most diagnosed pathologies, laparoscopy should be considered in the majority of patients with an acute abdomen.

1.4 Exploratory Laparotomy

For those with suspected intra-abdominal pathologies, and certainly those with evidence of peritonitis, laparotomy is still the gold standard. Patients with an acute abdomen and a contraindication to laparoscopy require laparotomy. Especially critical in the decompensating patient, laparotomy has the ability to diagnose with absolute certainty and provide treatment of the disease. However, exploratory laparotomy has significantly higher morbidity (5–22%), compared to diagnostic laparoscopy. Thus, in stable patients without contraindications, a minimally invasive approach should be considered.

Conclusions

The three modalities—CT, DL, and LAP—are individually very accurate and thus frequently employed. Rather than consider them competitive, they are complementary tests that have major roles in acute care surgery.

References

1. Lee D, Park MH, Shin BS, Jeon GS. Multidetector CT diagnosis of non-traumatic gastroduodenal perforation. J Med Imaging Radiat Oncol. 2015;60(2):182–6.
2. Grassi R, Romagno S, Pinto A, Romano L. Gastro-duodenal perforations: conventional plain film, US and CT findings in 166 consecutive patients. Eur J Radiol. 2004;50(1):30–6.
3. Fidler J, Paulson EK. Layfield l. CT evaluation of acute cholecystitis: findings and usefulness in diagnosis. AJR Am J Roentgenol. 1996;166(5):1085.
4. Paulson EK. Acute cholecystitis: CT findings. Semin Ultrasound CT MR. 2000;21(1):56.
5. Bennett GL, Balthazar EJ. Ultrasound and CT evaluation of emergent gallbladder pathology. Radiol Clin North Am. 2003;41(6):1203–16.
6. Yarmish GM, Smith MP, Rosen MP, Baker ME, Blake MA, Cash BD, Hindman NM, Kamel IR, Kaur H, Nelson RC, Piorkowski RJ, Qayyum A, Tulchinsky M. ACR appropriateness criteria right upper quadrant pain. J Am Coll Radiol. 2014;11(3):316–22.