ORIGINAL RESEARCH

Comparison of Abdominopelvic CT Diagnoses at Academic Teaching Hospitals in Rwanda and the United States

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Abstract

Purpose: The purpose of this study was to compare the disease processes encountered on abdominal and pelvic CT examinations at academic teaching hospitals in Rwanda and the United States and to highlight how these differences may impact a global radiology collaboration.

Materials and Methods: In this retrospective study, we included 130 patients (mean 59 +/-17 years, range 20-91, F:M 74:56) who underwent abdominal/pelvic CT examinations between April 1st-12th, 2019. CT examinations were prospectively encountered in clinical work at the Centre Hospitalier Universitaire de Kigali or University Teaching Hospital of Kigali (CHUK) in Kigali, Rwanda, where the radiology report impression, patient age, gender, study indication, CT protocol, and clinical diagnosis were recorded when available. Abdominal/pelvic CT examinations at the Massachusetts General Hospital (MGH) in Boston, Massachusetts, United States were then retrospectively reviewed for the same information. Patient age and gender were compared using Student's t-test and Chi-square statistic. Frequency of formal recommendations in radiology reports, available comparison of CT examinations, presence of known diagnoses, and intravenous and oral contrast media use were compared using Fisher's exact test. Diagnostic categories were qualitatively compared.

Results: A wide variety of pathology was encountered by abdominal/pelvic CT at both sites of imaging, with qualitative differences observed in cancer types, infectious agents, and how imaging guides care. Patients in Rwanda were older (p=0.0017), more likely to receive intravenous (p < 0.05) and positive oral contrast (p < 0.05) media and less likely to receive a formal recommendation in their radiology report (p < 0.05). Patients in the United States were more likely to have an available prior abdominal/pelvic CT (p < 0.05), to present for follow-up of a known diagnosis (p < 0.05), and to receive a formal recommendation in their radiology report (p < 0.05).

Conclusion: Participation in global radiology collaborations is beneficial for radiologists by broadening exposure to pathologies and practice different from their own institution and region.

Introduction

The first radiology residency program in Rwanda, a low- and middle-income country (LMIC), was founded in 2016, based at the Centre Hospitalier Universitaire de Kigali or University Teaching Hospital of Kigali (CHUK), an academic hospital and the largest referral center in the country. The radiology department at the Massachusetts General Hospital, a quaternary-care, academic hospital in Boston, Massachusetts, United States, a high-income country (HIC), has partnered with the radiology department and residency program at CHUK in developing a bidirectional, longitudinal, clinical and educational global radiology relationship between our practicing and in-training radiologists. During a two-week clinical rotation on site in Rwanda, we anecdotally noted the role imaging played in guiding patient care in our two sites, including the types of pathology encountered and how imaging guides management. The diversity of disease processes between the two sites is an asset for education of in-training and practicing radiologists based at both centers.

The purpose of this retrospective, dual-center study was to compare the pathology encountered in adults undergoing abdominal and pelvic CT examinations between academic teaching hospitals in Rwanda and the United States, to highlight differences in the roles of imaging in guiding patient care between LMIC and HIC healthcare settings, and to reflect on how these differences enhance the ongoing collaboration between our radiologists. We also share strategies used to build a longitudinal, bidirectional global radiology collaboration.

Materials and Methods

Subjects

This study was Institutional Review Board (IRB) approved and complied with the Health Insurance Portability and Accountability Act (HIPAA) guidelines. Subject informed consent was not required because of the retrospective study design. During an on-site clinical rotation in Rwanda at CHUK between 4/1/2019 and 4/12/2019, the following information was recorded for two weeks of consecutively encountered adult abdominal and pelvic CT examinations: study indication, patient gender, age, CT report impression, including recommendation if present and presumptive or proven diagnoses. Cases were encountered and read based on triage by the department administrative assistant or when a referring team consulted the reading room in person to obtain an interpretation and finalized report. Subsequently, a retrospective search was performed using Render, an institutional online radiology report repository in the United States at MGH, for abdominal and pelvic CT examinations over the same 2-week period between 4/1/2019 and 4/12/2019[1]. The first 65 consecutively performed CT examinations and electronic medical records for these patients were reviewed by an abdominal radiologist with three years of subspecialty experience [MAA].

Data Analysis

At CHUK, patient history was taken either from the hard copy requisition or in person from a referring physician, when available, during clinical interpretation. Gender and age of the patient were recorded. Presumptive diagnosis was recorded based on imaging and clinical information or on pathological results, when available. A diagnostic category was assessed for each case including malignancy, benign mass, infectious/inflammatory, vascular, congenital, and negative defined as no abnormality identified. Number and type of recommendations made in the report impressions were recorded. Whether CT was performed to follow-up a known diagnosis or was a search for a cause of symptoms was recorded for each patient.

On retrospective review of CT examination performed at MGH, CT examination indication, patient gender, age, and presumptive or proven diagnosis were recorded during retrospective review. Electronic medical records were examined after at least one-year of follow-up time interval to obtain further information about diagnoses encountered by CT imaging. The same diagnostic categories applied to cases encountered at CHUK were applied. Number and type of recommendations made in the CT report impressions were recorded. Patient status as inpatient or outpatient at time of imaging, presence of prior comparison abdominal and pelvic CT imaging, and whether CT was performed to follow-up a known diagnosis or was a search for a cause of symptoms was recorded for each patient.

CT Technique

CT examinations performed at CHUK were performed on a 64-slice helical CT scanner (Siemens Healthcare, Erlangen, Germany). The patients included in the study underwent three-phase CT including unenhanced and intravenous contrast enhanced abdominal and pelvic CT including arterial (30-40 second delay) and portal venous phase (65-70 second delay), with positive enteric contrast.

CT examinations performed at MGH ranged across multi-vendor CT equipment including 16-slice, 64-slice, 128-slice, single-energy, and dual-energy scanners. The patients included in the study underwent routine unenhanced or intravenous contrast enhanced abdominal and pelvic CT including portal venous phase (65-70 second delay after administration of intravenous contrast). Positive oral contrast media was administered when indicated. For examinations without intravenous contrast, unenhanced CT was performed after administration of enteric contrast, when indicated. When intravenous contrast was used, 80-120 mL of nonionic contrast material (370 mg/mL) was injected at a rate of 3.0 mL/s. Axial five mm slice thickness images were obtained and three mm coronal and sagittal images were reformatted.

Statistical Analysis

All statistics were performed using JMP®, Version 13.0.1 Pro (SAS Institute Inc.). A p-value < 0.05 was used as the critical alpha level for statistical significance for all tests. Mean age between patients in each group was compared using Student's t-test. Frequency of gender between groups were compared using Chi-squared test. A Fisher's exact test was used to determine if there were significant differences in the number of recommendations made in the CT report impressions, number of patients who had a prior available abdominal/pelvic CT for comparison, and number of patients who presented to CT for follow-up of a known diagnosis, between the two sites of imaging.

Given the short study period, small sample size, and low number of pathologically proven cases from CHUK, we refrain from statistical comparison of specific diagnostic categories across sites and instead present the diagnostic entities encountered in table for qualitative, descriptive comparison to illustrate differences in clinical practice rather than epidemiologic comparison of disease frequency (Table 1).

Results

Patients encountered by abdominal and pelvic CT imaging at CHUK included 34 woman and 31 men with a mean age of 63 +/-15 years (range 20 to 90). Exam protocol for all 65 patients included intravenous and positive oral contrast media. Based on provided history and available follow-up information obtained in person from referring physicians, 10 of 65 cases (15.4%) had pathologically proven diagnoses while the remaining 55 cases (84.6%) had only presumptive diagnoses based on imaging and/or history (Table 1). The most common malignancies were gastric (n=7/31, 22.6%), hepatobiliary (n=6/31, 19.4%) including HCC, cholangiocarcinoma, and gallbladder malignancy. The most common etiology of infectious/inflammatory etiology was abdominal tuberculosis (n=3/15, 20%). One recommendation (n=1/65, 1.5%) was made for additional imaging, for a scrotal ultrasound. One patient (n=1/65, 1.5%) had a prior abdominal and pelvic CT for comparison. Nine patients (n=9/65, 13.8%) underwent imaging for follow-up of a known, pre-existing condition.

Patients encountered by abdominal and pelvic CT imaging at MGH included 40 women and 25 men with mean age 54 +/-17 years (range 27 to 91). At the time of imaging, patient care setting included 47 outpatients (72%), 12 inpatients (19%),

	CHUK, Rwanda	MGH, United States
Malignancy	31	32
Luminal Gastrointestinal	12	3
Hepatobiliary	6	2
Prostate	6	3
Gynecologic	4	2
Pancreatic	1	2
Cutaneous	1	0
Lymphoma	1	2
Testicular	1	0
Lung	0	8
Breast	0	8
Renal/Urinary Tract	0	2
Infectious/Inflammatory	15	28
Negative	10	3
Benign mass	7	1
Vascular	2	1

Table 1. Comparison of diagnoses encountered on abdominal/pelvic CTs.

	CHUK, Rwanda	**MGH, United States**	**Fischer Exact Test Statistic**
Recommendations	1	14	p < 0.05
Additional Imaging	1	11	
MRI	0	9	
CT	0	2	
US	1	0	
Subspecialty Consultation	0	3	
Gastroenterology	0	3	

Table 2. Comparison of formal recommendations made in radiology reports.

	CHUK, Rwanda	**MGH, United States**	**Fischer Exact Test Statistic**
Prior CT Available	1	50	p < 0.05
Known Diagnosis as CT Indication	9	44	p < 0.05

Table 3. Frequency of available prior CT and known diagnosis as indication for CT.

and six emergency room (9%). Exam protocols included 54 (83%) with versus 11 (17%) without intravenous contrast and 45 (69%) with versus 20 (31%) without oral contrast media. Diagnostic categories were assigned based on imaging findings and follow-up information from the electronic medical records examined at least one year from time of imaging [Table 1]. The most common malignancies were lung and breast (n=8/32, 25.0% each). The most common etiologies of infectious/inflammatory etiology were hepatic steatosis (n=7/28, 25.0%) and cirrhosis (n=5/28, 17.9%). Fourteen recommendations (n=14/65, 21.5%) were made in the impression of these reports including 11/65 (16.9%) for additional imaging and 2/65 (3.1%) for subspecialty consultation (Table 2). The most common recommendation was for abdominal MRI (n=8/14, 57.1%). Fifty patients (53/65, 81.5%) had a prior abdominal and pelvic CT for comparison. Forty-four patients (44/65, 67.7%) underwent imaging for follow-up of a known, pre-existing condition.

There was no difference between frequency of gender between two sites of imaging X^2 (1, N = 130) = 1.1293, p = 0.29. Patients encountered in Rwanda (M=63, SD=15) were older than patients in the United States (M=54, SD=17), t(129) = 3.2, p=0.0017) and more likely to have intravenous (p < 0.05) and positive oral contrast media (p < 0.05). Patients encountered in the United States were more likely to have a prior abdominal/pelvic CT available for comparison at time of interpretation (p < 0.05), to have CT examination for follow-up of a known diagnosis as the study indication (p < 0.05), and to have a recommendation made in the impression of their radiology reports (p < 0.05) [Tables 2, 3].

Discussion

A wide range of pathology was encountered in patients imaged with abdominal and pelvic CT during equivalent, short intervals at our two partner institutions. Multiple patients at CHUK had gastric and cervical malignancies and abdominal tuberculosis versus none at MGH. The most common malignancies at MGH were lung and breast primaries and the most common etiology of infectious/ inflammatory entity was hepatic steatosis, none of which were encountered at CHUK.

In addition to differences in pathology seen on abdominal/ pelvic CT, their findings were used to make formal recommendations with different frequency across sites. Additional imaging was recommended only once in Rwanda, for ultrasound, whereas it was made more frequently and mostly for MRI in the United States. Subspecialty consultation, in all cases for gastroenterology, was only made in the United States based on imaging. These differences in radiology report recommendations likely reflect underlying differences in healthcare access between the LMIC and HIC sites, specifically related to medicine subspecialists as well as advanced imaging modalities such as MRI. CHUK specifically is a public institution that does not have an MR scanner; patients needing MRI would have them performed at a private hospital elsewhere in the city reflecting differences in availability of modalities at our institutions, specifically MRI. Variety in access to additional imaging modalities and preventative care was also manifest in the significant difference in patients who had a prior CT examination available for comparison and those who had the CT performed to follow-up on a known diagnosis. In Rwanda, where only one patient had a prior CT available

and less than 15% of patients had a known diagnosis at time of scanning, the initial imaging study is likely to be the only one to make the diagnosis. Conversely, in the United States, more than 80% of patients had a prior CT for comparison and nearly 70% underwent imaging for follow-up of a known condition.

Our descriptive comparison of specific disease entities does not have the appropriate sample size to draw epidemiological conclusions about disease frequency. Instead, this comparison supports our anecdotal recognition of differing and varied pathologies across our regions during a two-week collaboration. However, reports of disease frequency in Rwanda are consistent with our limited case series, as two published reports of malignancy frequency found high rates of gastric, hepatic, and cervical cancers [2, 3]. Given that all three of these malignancies are associated with viral infections as causative (Helicobacter pylori and Epstein-Barr for gastric, hepatitis B and C for hepatocellular carcinoma, and human papillomavirus for cervical cancer) a higher rate of viral infections may contribute to cancer incidence [4–6]. Additionally, lack of widespread Papanicolaou (Pap) smear use in this relatively low resource setting likely contributes to cases of cervical cancer [6].

Based on this initial review of cases from our collaboration, the fact that there may be differing frequencies of diseases encountered provides an opportunity to leverage the pathological diversity to the advantage of trainees at both our collaborating institutions. This is a unique educational opportunity for in-training radiologists to broaden the scope of imaging manifestations of diseases encountered in clinical practice through global radiology collaboration.

At both institutions, CT procedures and protocols existed and were available. Neither institution obtained written consent for intravenous contrast. However, there were differences in CT operations at our institutions. To our knowledge, this is the first report of comparison of CT operations between HIC and LMIC healthcare facilities.

At CHUK, CT technique was more uniform, all using both oral and intravenous contrast. Scans were not individually protocolled and contrast injection rate was four ml/second. Every patient received a systematic creatinine check prior to CT scan, with a cutoff of 2 mg/dL, above which patients were not given intravenous contrast. If patients had creatinine between 1/5-2 mg/dL and chronic rather than acute renal dysfunction, they could be transferred from CHUK to a private hospital which has isosmolar contrast available, if a funding source is available. Patients were verbally screened for contrast allergy by the technologist. A written policy for contrast reactions exists and by this policy a study was cancelled if patient had known contrast allergy. If a patient developed an allergic-type reaction when given contrast, hydrocortisone 100 ml IV was administered. No screening for metformin occurred. Archived image data on the CT console was stored for approximately one week, depending on the volume of the scanner. For all scans, five mm thick axial with 1.5 mm coronal and sagittal reconstructions were obtained.

No software apart from standard PACS was available for multiplanar reconstructions. If the CT scanner was down for repair, patients in need of imaging could be diverted to the local military or private hospital. The CT scanner was available 24 hours per day, seven days per week, but only utilized during nighttime hours for true emergencies. During daytime hours, a dedicated nurse screened requests to prioritize and triage patients based on level of urgency.

At MGH, CT protocols were more variable in usage of oral and intravenous contrast, which when used was injected at 2.5-3 ml/second depending on IV-line size. No consent was taken for intravenous contrast administration. Patients were screened for contrast allergy automatically in the electronic medical record and verbally by technologists. Patients with glomerular filtration rate (GFR) less than 30 mL/min/1.73 m2 required radiologist approval for administration of IV contrast based on discussion of necessity and risk with the referring physician. If GFR was less than 30 mL/min/1.73 m2, metformin was held for 48 hours following the scan by protocol. CT scanner up-times varied from 24 hours per day 7 days per week for emergency department scanners, to 6 am – midnight for inpatient scanners, and 6 am – 7 or 11 pm for outpatient scanners. Archived image data on the CT consoles were stored for 1-4 weeks depending on the volume of the scanner. For routine acquisitions, five mm thick axial with three mm coronal and sagittal reconstructions are obtained, with some scanners also producing 1.25 mm axial thin sections. TeraRecon (TeraRecon, Inc., Foster City, California, USA) software was available for multiplanar reconstructions.

Comparing differences in protocols for CT, and other imaging, provides radiologists and trainees the opportunity to learn from partnering institutions so that examinations can be tailored to answer the clinical question while optimizing risk and cost to patients as well as department workflow and throughput. Radiologists from both sites felt they benefitted greatly from interacting with and learning from radiologists at the partners sites. CHUK felt they benefited from subspecialty experience of MGH radiologists who practiced a more limited breadth but had a depth of experience in their field. The presence of additional staff radiologists also allowed the clinical work to be more spread out during the time of exchange so that both MGH and CHUK radiologists could focus on dedicated didactic lectures and allow for greater time spent doing teaching at the workstations. By the same token, MGH trainees and staff felt the breadth of general radiology seen in clinical work and from the broad expertise of the CHUK faculty was of great benefit to broaden their exposure to different areas of radiology. We acknowledge the need to change pre-test probabilities of diagnoses that may differ in frequency between regions. For example, cases of peritoneal inflammation, ascites, and abdominopelvic lymphadenopathy have a far higher pretest probability of being secondary to tuberculosis at CHUK. In part due to our collaborations, a gastric cancer protocol CT with negative oral contrast has been implemented at CHUK.

In addition to sharing differences in CT operations and imaging findings encountered, we would like to share some strategies used in building our global radiology collaboration, that may be beneficial for institutions seeking to build similar relationships. Creating a longitudinal exchange, rather than a one-time visit, has the advantages of creating more trusted and impactful relationships and continuity of teaching and learning. Critically, these relationships must be formed prioritizing the needs of the global partner rather than the desires of the home institution. Such a relationship required the support of our department chair, division heads, and residency and fellowship program directors in allowing the scheduling flexibility for trainees and attending radiologists to take multiple-week blocks away from on-site clinical duties. Engaging departmental leadership early in a collaboration is crucial. Pursuing a sustainable, recurring, and bidirectional exchange will benefit both institutions involved since trainees will likely benefit more from on-site learning and clinical practice, than from lectures alone. In order to encourage participations, we have tried to readily disseminate information about our collaboration by giving talks to residents, fellows, and at staff meetings about opportunities and using images to show the interesting cases encountered and share our experiences traveling and learning. We have also tried to share details and logistics by creating a shared, living document accessible and editable by subsequent radiologists of important, people, places, and information to make the experience more familiar and accessible, such as the names of attending and trainee radiologists at our partner institution, names of radiologic technologists, restaurants, information for a trusted taxi driver, and maps of the hospital and residential neighborhood. Although the COVID-19 pandemic has put a hold on our exchange, we hope to resume as soon as is safe and feasible. We have found new remote ways to continue our collaboration, such as using web-conferencing to allow faculty at both sites to participate in resident thesis dissertation review in Rwanda. Lastly and importantly, we would like to emphasize that in line with good global health and global radiology practice, neither site of this collaboration seeks to transplant their methods of conducting radiology, but to assist each other in making the most optimal use of available resources in each of our own environments.

Limitations of this case series include a small number of patients, with cases biased toward being positive and acutely ill since these were not consecutively scanned patients but consecutively read based on triage, often driven by clinical demand at CHUK. Additionally, these cases should not be taken as representative of spectrum or severity of pathology seen in Rwanda, since the population seen at CHUK, a teaching hospital and referral center, are likely selected for higher acuity. Due to a time-limited rotation and lack of electronic medical record, a minority of cases had pathologically proven diagnoses while most cases had only presumptive diagnoses.

Conclusion

Participation in global radiology collaborations is beneficial for trainee and practicing radiologists from both sites, evidenced by significant differences in pathologies encountered, imaging protocols, and practice patterns between institutions that are mutually educational. Creation of a longitudinal, bidirectional educational exchange between radiology departments can be accomplished with the appropriate departmental support systems.

Conflicts of interest

All authors declare they have no conflicts of interest.

Ethics approval: This retrospective study involving human participants was in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent: Informed consent was waived for individual participants included in the study. The study was Institutional Review Board (IRB) approved and HIPAA compliant.

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