Abnormal CT findings among patients with abdominal pain in the radiology department of a tertiary care center [version 1; peer review: awaiting peer review]

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Abstract

Background: Abdominal pain is a common symptom in people of different ages due to various benign and life-threatening causes. Imaging studies, including computerized tomography (CT) scans, explore the clinical reasons behind this pain to prevent delayed diagnosis. Owing to abnormal findings, timely identification of the exact cause of abdominal pain is important in most diseases so treatment can be started earlier, but it has not yet been studied, making this research novel. This study was conducted to identify the prevalence of abnormal CT scan findings among referred patients with abdominal pain and to confirm or determine other diagnoses compared to other imaging modalities in the Emergency Department (ED).

Methods: This observational retrospective study was conducted at the King Fahad Hospital, a tertiary hospital in Qassim. We included 2,144 patients who visited the ED and underwent abdominal CT scans between January 2021 and January 2022. Data on age, sex, CT findings, and results from other imaging modalities were collected from the Radiology Department.

Results: We found that 2,144 patients referred from the ED to the Radiology Department complained of acute abdominal pain in 2021 for CT diagnosis. Approximately 28.2% of these patients had normal CT diagnoses. The average age at normal CT diagnosis was 38.6 years old. While 52% of CT diagnoses were abnormal, including obstructive ureteric stone (435, 20.3%), appendicitis (205, 9.6%), bowel obstruction (51, 2.4%), renal cancer (27, 1.3%), ovarian cancer (25, 1.2%), and obstructive bladder stone (25, 1.2%), with an average age of 40.4 years old, and 19% with accidental findings.
Conclusions: Most of the cases with abdominal pain showed abnormal results in the CT scan. These results demonstrate the sole inefficiency of CT scan for the diagnosis of abdominal pain. So, clinical evaluations should be used together with abdominal ultrasonography to perform a timely and exact diagnosis.

Keywords
Ct, abdominal pain, radiology, radiology department, ct abdomen, tomography

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Introduction

Abdominal pain is common in patients who are admitted to hospital with various etiologies, ranging from benign to life-threatening (Cartwright and Knudson, 2015; Jastaniah et al., 2015; Master et al., 2005; Stoker et al., 2009; Waheed et al., 2019). Globally, it is estimated that approximately 10% of patients in the Accident and Emergency (A&E) Department complain of acute abdominal pain (Mulmi et al., 2021). In the Al-Ahsa region of Saudi Arabia, 32.2% of residents reported abdominal pain once a month, while 5% had abdominal pain daily (Albattat et al., 2020). Acute severe abdominal pain may require surgery and is often urgent. Chronic pain can result in long-term morbidity and requires multidisciplinary management (Albattat et al., 2020). Considering the wide range of causes of abdominal pain with similarities in early clinical presentation, imaging studies are used to identify specific causes and prevent delays in diagnosing life-threatening conditions that may require urgent surgical interventions (Rosen et al., 2000). In addition, physical and laboratory examinations are often not specific.

Timely identification of critical life-threatening causes remains a challenge. Computerized tomography (CT) helps examine patients with an acute abdomen to identify abdominal and pelvic organ pathologies (Master et al., 2005), making CT scan the primary technique for the diagnosis of acute abdominal pain because it is more accurate and informative (Nachiappan et al., 2018; Stoker et al., 2009).

Studies have found that non-traumatic abdominal pain is more common in women (58.7%) than in men, and right upper quadrant (RUQ) tenderness is associated with abnormal CT findings (Mulmi et al., 2021; Zgeib et al., 2020). Master et al., studied CT scan reports of 383 patients. They found that most (75.9%) had adverse CT scan reports and 11.7% had unrelated reports unrelated to symptoms, with one unrelated finding leading to ovariectomy for a benign tumor (Master et al., 2005). The most positive findings were liver metastases, and irrelevant findings were organomegaly and internal organ masses that required further evaluation and specialist consultation (Master et al., 2005). However, in Italy, a study investigating the prevalence of relevant incidental findings detected during routine abdominal contrast-enhanced CT showed relevant incidental findings (mostly involving the kidneys, gallbladder, and lungs) in one-fifth of patients, increasing with age but peaking at 40–49 years old (Sconfienza, 2015).

In Poland, a study of 20 patients aged between 20–70 years old (five with suspected cholecystitis, eight with suspected appendicitis, four with suspected diverticulitis, and three with renal colic with suspected ureteric stones) showed that CT scan diagnoses of those patients were different from clinical diagnoses, but also led to accurate, definitive diagnoses. In this study, CT scan showed omental infarctions in 13 patients on CT scan images and features of epiploic appendicitis in the other seven patients. The former underwent laparoscopic excision of omental infarctions and the latter was treated with conservative management (Kamr et al., 2019).

In a study conducted to assess the prevalence and clinical relevance of positive abdominal and pelvic CT findings in older adults (>65 years old) patients, appendicitis, diverticulitis, colitis/enteritis, and genitourinary and gynecological disorders were the most common CT findings in patients aged <65 years old. By contrast, bowel obstruction, bowel ischemia or perforation, gastrointestinal bleeding, biliary tract findings, ruptured abdominal aortic aneurysm, and malignancy were more common in older patients. Complications were more common in older patients (50%) than in those aged <65 years old (27%). However, no statistically significant differences in the clinical relevance of CT findings were found in either group (Alaboussi et al., 2016). Zgeib et al., found that epigastric tenderness was not associated with abnormal CT results. The same findings were reported in another study that discussed the role of multi-detector CT in the diagnostic workup of acute abdominal pain (Leschka et al., 2005).

In Jordan, a study evaluating the routine use of CT scanning in patients with abdominal pain at the A&E Department revealed that CT may reduce mortality and hospital admissions. However, clinical assessment is a crucial first step in deciding when to use CT scans (Al-Mherat, 2012). In this study, 41% of the patients who presented with abdominal pain underwent a CT scan, and 61.2% had abnormal CT findings. Urinary tract stones were the most common finding (57.8% of abnormal CT findings), while the rest had other conditions. They and other studies have also found that a good clinical evaluation is primary in guiding management, diagnostic choices, and therapeutic decisions (Nachiappan et al., 2018; Sconfienza, 2015).

A study conducted at the Department of Diagnostic Radiology, Faculty of Applied Medical Sciences, King Abdul-Aziz University, Jeddah, Saudi Arabia, proved that CT detects urgent conditions and can be used to diagnose patients with abdominal pain (Jastaniah et al., 2015). Another study conducted in Dhahran, Saudi Arabia, found that CT scan indicated an abnormality in nearly 90% of the cases, with appendicitis being the most detected in 30% of patients. In complex issues, CT scans outperform US (Waheed et al., 2019).
Objective
This study explored the prevalence of abnormal CT scan findings among referred patients with abdominal pain at King Fahad Hospital, the Radiology Department, Qassim, Saudi Arabia.

Methods
Ethical considerations
All information was obtained after obtaining ethical approval from the Regional Research Ethics Committee of Qassim Province with registration number: 607-43-148 on March 21, 2022. Approval from the King Fahad Hospital was also obtained. The consent of participants was waived by the ethical committee.

Study design and setting
This observational retrospective study was conducted at the King Fahad Hospital, a tertiary healthcare hospital in Burydah, Qassim region, Saudi Arabia. This study included 2,144 patients who underwent abdominal CT scans in the ED due to abdominal complaint. All patients aged ≥14 years old who presented with abdominal pain and underwent abdominal CT from 1 January to 30 December 2021 were included. We excluded patients who underwent CT scan for indication other than undiagnosed abdominal pain, trauma-related abdominal pain, abdominal pain during pregnancy and post-operative period. Starting from 1 January 2021 until 1 January, 2022. Imaging was requested by a certified physician from ED at King Fahad Hospital and collected from the Radiology Department by the researchers.

Data collection methods
This study was facilitated by one of the research members affiliated to the Radiology Department of the King Fahad Tertiary Hospital and after creating a new user specialized for this study. Data were collected immediately after ethical approval was obtained, from March 23, 2022, until April 17, 2022. Demographic characteristics, past medical and surgical history, symptom description and physical examination findings, diagnosis (both initial and final), laboratory tests, CT findings, and results from other requested radiology modalities were obtained from the hospital system.

Data analysis
We used IBM SPSS Statistics (RRID: SCR_016479) version 25 software for statistical analysis, and variables are represented as frequencies and percentages. Pearson's chi-squared test was used for categorical variables and to compare the positive and negative CT findings between women and men. A post hoc chi-squared test was then used to compare positive CT results for various diagnoses. Statistical significance is set at a p-value of less than 0.05. We also performed multivariate analyses for both the dependent variables. Variables found to be statistically significant at the bivariate level and those considered clinically meaningful were included in logistic regression analysis.

Results
Among the 2,144 patients referred from the ED to the Radiology Department complaining of acute abdominal pain in 2021 for CT diagnosis, approximately 605 (28.2%) of these patients had a normal CT diagnosis. The average age at normal CT diagnosis was 38.6 years old. Among the 605 normal cases, 196 patients underwent other radiological modalities that preceded the CT diagnosis, including abdominal X-ray, kidneys, ureters, bladder (KUB) X-ray, and US that were normal. The other 419 (19.5%) cases were accidental findings, that is, unrelated to the signs and symptoms of abdominal pain; the most common accidental finding was non-obstructive renal stone in 108 cases (24.9%), followed by non-obstructive ureteric or bladder stone in 36 cases (8.3%). The other 52.3% cases of CT diagnosis included obstructive ureteric stone, 435 (20.3%); appendicitis, 205 (9.6%); bowel obstruction, 51 (2.4%); renal cancer, 27 (1.3%); ovarian cancer, 25 (1.2%); and obstructive bladder stone, 25 (1.2%), with an average age of 40.4 years old. The most common modality is abdominal CTK UB followed by abdominal CT scan with contrast (W/C) across all CT diagnoses (Almushayti et al., 2022) (Table 1).

Table 1. Frequency and percentage of accidental and non-accidental CT scan findings. CT, computerized tomography.

| CT diagnosis            | Utilization | Utilization | Non-accidental (%) | Accidental (%) |
|-------------------------|-------------|-------------|--------------------|----------------|
| Normal                  | 605         | 28.2%       | 100%               | 0%             |
| Obstructive ureteric stone | 435         | 20.3%       | 61%                | 39%            |
| Appendicitis            | 205         | 9.6%        | 54%                | 46%            |
| Bowel obstruction       | 51          | 2.4%        | 61%                | 39%            |
| Renal cancer            | 27          | 1.3%        | 63%                | 37%            |
Table 1. Continued

| CT diagnosis                  | Utilization | Utilization | Non-accidental (%) | Accidental (%) |
|-------------------------------|-------------|-------------|--------------------|----------------|
| Ovarian cancer                | 25          | 1.2%        | 48%                | 52%            |
| Bladder stone                 | 25          | 1.2%        | 48%                | 52%            |
| Chron's disease               | 19          | 0.9%        | 63%                | 32%            |
| Cystitis                      | 18          | 0.8%        | 39%                | 61%            |
| Gall stone                    | 18          | 0.8%        | 61%                | 39%            |
| Pancreatitis                  | 18          | 0.8%        | 78%                | 22%            |
| Colon cancer                  | 14          | 0.7%        | 71%                | 29%            |
| Colitis                       | 12          | 0.6%        | 75%                | 25%            |
| Pelvic mass                   | 10          | 0.5%        | 50%                | 50%            |
| Ascites                       | 9           | 0.4%        | 67%                | 33%            |
| Cholangiocarcinoma            | 8           | 0.4%        | 88%                | 13%            |
| Cirrhosis of the liver        | 8           | 0.4%        | 88%                | 13%            |
| Pyelonephritis                | 7           | 0.3%        | 29%                | 71%            |
| Cholecystitis                 | 7           | 0.3%        | 43%                | 57%            |
| Mesenteric adenitis           | 6           | 0.3%        | 83%                | 17%            |
| Cholelithiasis                | 6           | 0.3%        | 50%                | 50%            |
| Ruptured luteal cyst          | 4           | 0.2%        | 0%                 | 100%           |
| Hepatitis                     | 4           | 0.2%        | 50%                | 50%            |
| Rectal cancer                 | 3           | 0.1%        | 33%                | 67%            |
| Ogilvie syndrome              | 3           | 0.1%        | 67%                | 33%            |
| Lymphoma                      | 3           | 0.1%        | 100%               | 0%             |
| Pneumoperitoneum              | 3           | 0.1%        | 33%                | 67%            |
| Splenic infarction            | 3           | 0.1%        | 67%                | 33%            |
| Hydroureteronephrosis         | 3           | 0.1%        | 67%                | 33%            |
| Perforated peptic ulcer       | 2           | 0.1%        | 50%                | 50%            |
| Metastatic pancreatic cancer  | 2           | 0.1%        | 100%               | 0%             |
| Gastric cancer                | 2           | 0.1%        | 50%                | 50%            |
| Endometriosis                 | 2           | 0.1%        | 50%                | 50%            |
| Rectosigmoid mass             | 2           | 0.1%        | 50%                | 50%            |
| Ileus                         | 2           | 0.1%        | 50%                | 50%            |
| Others                        | 573         | 26.7%       | 13%                | 14%            |

Figure 1 indicates that in January, the percentage of normal findings was 7.2%, while 6.9% of patients had obstructive uretic stone, 9.3% had appendicitis, 15.7% had bowel obstruction, 3.7% had renal cancer, 8% had ovarian cancer, and 0% had bladder stones. In February, it was concluded that 2.6% of patients had appendicitis, 4.9%, had bowel obstruction, 0% had ovarian cancer, 4%, had renal cancer and 3% of the patients had obstructive uretic stone.

In March, it was shown that 6.7% of patients had obstructive uretic stone, 6.7% had bowel obstruction, 7.8% had renal cancer, 11.1% had ovarian cancer, and 12% had bladder stone. The April month demonstrated that normal, obstructive uretic, appendicitis, bowel obstruction, renal cancer, ovarian cancer, and bladder stone were found in 6.1%, 7.6%, 7.3%, 2%, 14.8%, 8%, and 4% of patients, respectively. In June, normal was found in 10% of patients, obstructive uretic stone in 8.5%, appendicitis in 8.8%, bowel obstruction in 5.9%, renal cancer in 11.1%, ovarian cancer in 4%, and bladder stone in 4%. July showed that normal was found in 9.8% of patients, obstructive uretic stone in 15.6%, appendicitis in 11.7%, bowel obstruction in 13.7%, renal cancer in 7.4%, ovarian cancer in 4%, and bladder stone in 4%. In August, normal was found in 10.4% of patients, obstructive uretic stone in 12.4%, appendicitis in 9.8%, bowel obstruction in 3.9%, renal cancer in 22.2%, ovarian cancer in 16%, and bladder stone in 12%. The September month of this data analysis showed
that the normal, obstructive uretic, appendicitis, bowel obstruction, renal cancer, ovarian cancer, and bladder stones were found in 11.1%, 9%, 6.3%, 15.7%, 7.4%, 16%, and 16% of patients, respectively. In October, 9% of the patients were normal, 7.8% had obstructive uretic stone, 9.8% had appendicitis, 9.8% had bowel obstruction, 0% had renal cancer and 8% had bladder stones. November demonstrated that normal, obstructive uretic, appendicitis, bowel obstruction, renal cancer, ovarian cancer, and bladder stones were found in 9%, 4.8%, 5.4%, 11.8%, 11.1%, 8%, and 20% of patients, respectively. While, at last, December showed that normal was found in 9.9% of patients, obstructive uretic stone in 8.7%, appendicitis in 6.3%, bowel obstruction in 13.7%, renal cancer in 0%, ovarian cancer in 8%, and bladder stone in 16%.

Figure 2 shows that more than 25% of CT findings were normal and decreased gradually with obstructive uretic stone, appendicitis, bowel obstruction, renal cancer, ovarian cancer, and bladder, all of which are abnormally diagnosed. This graph represents the entire range of normal and abnormal cases, with their percentages. The results showed that the total number of normal cases was 605 (28.2%). The total number of obstructive uretic stones was 419 (19.5%). There were 205 (9.6%) appendicitis cases. The number of patients with bowel obstruction was 51, which is only 2.4% of all patients. The number of cases of renal cancer was only 27 (1.3%). The number of ovarian cancer cases was 25, which is 1.2% of all cases and diagnosed only in women. Bladder stones were identified in 25 men, and only 1.2% of patients were referred to the Radiology Department.

Figure 3 shows the association between the normal and abnormal CT findings of abdominal pain. The blue line shows the overall percentage of normal obstructive uretic stone cases, appendicitis, bowel obstruction, renal cancer, ovarian cancer,
and bladder stone. The orange line shows non-accidental cases of abdominal pain. The gray line shows the cases that were accidental, abnormal, or not associated with abdominal symptoms.

Table 2 shows that most of the normal CT findings were found in female patients (67.3%) compared to male patients. Obstructive uretic stones were more frequently found in men than in women. The incidence of abnormal appendicitis was higher in men than in women. Furthermore, the incidence of renal cancer was higher in men (51.9%) than in women (48.1%). Hepatitis and lymphoma were reported only in men. Pneumopericardium was twice as high in women than in men. At the same time, splenic infarction was twice as frequent in men than in women.

Figure 3. Utilization, non-accidental, and accidental CT scan findings for abdominal pain. CT, computerized tomography.

| CT diagnosis                          | Male   | Female  | P-value | 95% CI   | Sig.  |
|--------------------------------------|--------|---------|---------|----------|-------|
| Normal                               | 32.70% | 67.30%  | 0.004   | 1.59–4.04 | 0.001 |
| Obstructive ureteric stone           | 60.00% | 40.00%  | 0.006   | 0.27–4.89 | 0.003 |
| Appendicitis                         | 57.10% | 42.90%  | 0.008   | 1.25–4.94 | 0.002 |
| Bowel obstruction                    | 52.90% | 47.10%  | 0.001   | 2.27–4.59 | 0.002 |
| Renal cancer                         | 51.90% | 48.10%  | 0.003   | 0.27–1.85 | 0.003 |
| Ovarian cancer                       | 56.00% | 44.00%  | 0.003   | 0.97–2.43 | 0.001 |
| Bladder stone                        | 56.00% | 44.00%  | 0.002   | 3.38–5.05 | 0.004 |
| Chronis                              | 63.20% | 36.80%  | 0.001   | 0.79–4.58 | 0.002 |
| Cystitis                             | 66.70% | 33.30%  | 0.003   | 2.29–4.85 | 0.005 |
| Gall stone                           | 61.10% | 38.90%  | 0.007   | 1.83–5.97 | 0.002 |
| Pancreatitis                         | 66.70% | 33.30%  | 0.002   | 2.27–3.85 | 0.003 |
| Colon cancer                         | 64.30% | 35.70%  | 0.006   | 1.27–3.56 | 0.002 |
| Colitis                              | 50.00% | 50.00%  | 0.004   | 1.27–3.53 | 0.001 |
| Pelvic mass                          | 60.00% | 40.00%  | 0.001   | 1.27–3.59 | 0.004 |
| Ascites                              | 44.40% | 55.60%  | 0.002   | 1.27–3.55 | 0.001 |
| Cholangiocarcinoma                   | 25.00% | 75.00%  | 0.003   | 1.27–3.56 | 0.002 |
| Cirrhosis of the liver               | 50.00% | 50.00%  | 0.002   | 1.27–3.58 | 0.001 |
| Pyelonephritis                       | 71.40% | 28.60%  | 0.007   | 1.27–3.52 | 0.003 |
| Cholecystitis                        | 42.90% | 57.10%  | 0.004   | 1.27–3.59 | 0.001 |
| Mesenteric adenitis                  | 83.30% | 16.70%  | 0.007   | 1.27–3.55 | 0.002 |
Table 3 shows that most of the normal results were observed in September, followed by August and June. Minor typical results were found in February (only 2.6%). While abnormal CT findings of obstructive ureteric stone were found to be highest in July, followed by August and May. In the same way, abnormal CT findings of appendicitis were found most elevated in March, followed by July and October. Other abnormal CT findings of bowel obstruction, renal cancer, ovarian cancer, and bladder stone were found to be highest in September and January, April, August and September, and November.

Table 1 shows that 28.2% of the patients had normal CT findings, while others had abnormal CT findings. A total of 20.3% (435) of the patients were diagnosed with obstructive ureteric stones, 9.3% with appendicitis, and 2.4% with bowel

Table 2. Continued

| CT diagnosis                  | Male       | Female     | P-value | 95% CI     | Sig. |
|-------------------------------|------------|------------|---------|------------|------|
| Cholelithiasis                | 33.30%     | 66.70%     | 0.005   | 1.27–3.50  | 0.005|
| Ruptured luteal cyst         | 50.00%     | 50.00%     | 0.004   | 1.27–3.51  | 0.003|
| Hepatitis                     | 100.00%    | 0.00%      | 0.004   | 1.27–3.53  | 0.001|
| Rectal cancer                 | 66.70%     | 33.30%     | 0.003   | 1.27–3.59  | 0.004|
| Ogilvie syndrome              | 33.30%     | 66.70%     | 0.008   | 1.27–3.50  | 0.001|
| Lymphoma                      | 100.00%    | 0.00%      | 0.008   | 1.27–3.59  | 0.004|
| Pneumoperitoneum              | 33.30%     | 66.70%     | 0.002   | 1.27–3.52  | 0.001|
| Splenic infarction            | 66.70%     | 33.30%     | 0.002   | 1.27–3.57  | 0.002|
| Hydroureteronephrosis         | 33.30%     | 66.70%     | 0.003   | 1.27–3.53  | 0.005|
| Perforated peptic ulcer       | 100.00%    | 0.00%      | 0.009   | 1.27–3.52  | 0.002|
| Metastatic pancreatic cancer  | 50.00%     | 50.00%     | 0.008   | 1.27–3.56  | 0.003|
| Gastric cancer                | 50.00%     | 50.00%     | 0.008   | 1.27–3.51  | 0.002|
| Endometriosis                 | 50.00%     | 50.00%     | 0.009   | 1.27–3.58  | 0.003|
| Rectosigmoid mass             | 100.00%    | 0.00%      | 0.007   | 1.27–3.50  | 0.001|
| Ileus                          | 50.00%     | 50.00%     | 0.009   | 1.27–3.51  | 0.005|
| Others                         | 15.70%     | 11.30%     | 0.007   | 1.27–3.58  | 0.002|

Table 3. Normal and abnormal CT findings throughout the year (12 months). CT, computerized tomography.

| Months  | Normal | Obstructive ureteric stone | Appendicitis | Bowel obstruction | Renal cancer | Ovarian cancer | Bladder stone |
|---------|--------|----------------------------|--------------|-------------------|--------------|---------------|---------------|
| January | 12.2%  | 6.9%                       | 9.3%         | 15.7%             | 3.7%         | 8.0%          | 0.0%          |
| February| 4.5%   | 3.0%                       | 4.9%         | 0.0%              | 0.0%         | 4.0%          | 0.0%          |
| March   | 11.4%  | 6.7%                       | 14.1%        | 7.8%              | 11.1%        | 12.0%         | 4.0%          |
| April   | 10.2%  | 7.6%                       | 7.3%         | 2.0%              | 14.8%        | 8.0%          | 4.0%          |
| May     | 13.9%  | 9.0%                       | 6.3%         | 9.8%              | 0.0%         | 4.0%          | 12.0%         |
| June    | 16.9%  | 8.5%                       | 8.8%         | 5.9%              | 11.1%        | 4.0%          | 4.0%          |
| July    | 16.5%  | 15.6%                      | 11.7%        | 13.7%             | 7.4%         | 4.0%          | 4.0%          |
| August  | 17.7%  | 12.4%                      | 9.8%         | 3.9%              | 22.2%        | 16.0%         | 12.0%         |
| September| 18.8% | 9.0%                       | 6.3%         | 15.7%             | 7.4%         | 16.0%         | 16.0%         |
| October | 15.2%  | 7.8%                       | 9.8%         | 0.0%              | 11.1%        | 8.0%          | 8.0%          |
| November| 15.2%  | 4.8%                       | 5.4%         | 11.8%             | 11.1%        | 8.0%          | 20.0%         |
| December| 16.7%  | 8.7%                       | 6.3%         | 13.7%             | 0.0%         | 8.0%          | 16.0%         |
| % Utilization | 28.2% | 20.3% | 9.6% | 2.4% | 1.3% | 1.2% | 1.2% |
obstruction. Ovarian cancer and bladder stones were found in 1.2% of patients. Less than 0.5% of patients were diagnosed with cystitis, gallstones, pancreatitis, colon cancer, colitis, pelvic mass, hepatitis, ascites, cholecystitis, ruptured luteal cyst, rectal cancer, gastric cancer, ileus, and others…

Discussion
This study examined the CT findings of patients at King Fahad Hospital who visited the hospital between January 2021 and December 2021 and were referred to the Radiology Department. These findings are essential for changing diagnostic imaging systems into the latest and quicker systems with high accuracy. It is estimated that most patients with abdominal pain have normal CT findings (28.2%). Participants aged ≥14 years old were included in the study. A total of 1,272 respondents were female, while 873 were male, indicating that most patients with abdominal pain were women due to a lower threshold for CT imaging. In a study conducted by Gibson et al., women were 11% more likely to undergo CT than men. Moreover, the percentage of women (58.7%) was higher than that of men (41.3%) in this study (Gibson et al., 2014). The variations in abnormal CT findings between men and women opens doors for further research to demonstrate novel associations. Women with abdominal pain are significantly more likely to have alternative diagnostic systems that are better visualized by CT scan and US, such as ruptured ovarian cysts, ectopic pregnancy, or pelvic inflammatory disease. A study conducted in 2013 by Bao et al., for acute abdominal pain, showed that more than 50% of the CT findings were abnormal and not concerned with abdominal pain (Bao et al., 2013). In another previous study, it was found that CT scan is used to diagnose most cancers in women because radiation can also determine the risk-prone women who can develop cancer in the future due to abnormal cell growth. Tirumani, in 2021 revealed that gastrointestinal disorders are always associated with acute abdominal pain, and CT scans are the first option for diagnosing gastrointestinal diseases, including cancer (Tirumani et al., 2021).

According to Kalish, ovarian cancer and ovarian cyst rupturing in women are due to gynecological abnormalities, followed mainly by chronic abdominal pain (Kalish et al., 2007). Wildman-Tobriner found that acute abdominal pain CT findings include appendicitis, acute cholecystitis, diverticulitis, renal disorders, peptic ulcer, bowel obstruction, infection in the urinary tract, and many others. The results of this study are similar to our research (Wildman-Tobriner et al., 2019).

The prevalence of abdominal CT findings among referred patients with abdominal pain is much higher than normal owing to the late diagnosis of other diseases. It is not the only research showing that CT findings have more than 50% of abnormal findings. Other studies support these findings (Ahn et al., 2002; Rosen et al., 2003; Stoker et al., 2009). CT scan findings have strong relevance with the initial diagnosis, which is life threatening, and patients are referred to the Radiology Department for better diagnosis. Our study did not find any significant association between abnormal CT findings in men, women, or additional months. A few months showed higher abnormal findings, while others showed fewer, so this association was missing in our study. In addition, with the deviation of abnormal CT findings from the expected normal results, it can be assumed that there is an interconnection between abdominal pain and abnormal findings. This research gap opens the door for future research. According to Rosen et al., normal CT findings increased the physician's level of certainty and reduced the hospital admission rate to 23.8%. However, abnormal and unexpected CT findings may lead to uncertainty for medical professionals and patients, with an increase in revenue. Therefore, the high rate of abnormal results in this study requires the development of more advanced diagnostic technology (Rosen et al., 2000).

Study limitations
There was no documented detailed history, physical examination, or unreported radiological imaging in the patient's file to accurately evaluate the effectiveness accurately.

Conclusions
Most of the patients (52%) with abdominal pain showed abnormalities in the results of the CT scan. So, CT scan should be used with the other imaging procedures such as US to diagnose the exact cause of abdominal pain in a timely manner. Abdominal US with CT scan is suggested for the diagnosis of patients with abdominal symptoms in the radiological department. It is recommended that US diagnostic imaging be performed as the first-line imaging modality for patients and further referral to respective departments can treat patients in less time.

Data availability
Underlying data
Zenodo: Abnormal CT findings among patients with abdominal pain in the radiology department of a tertiary care center. https://doi.org/10.5281/zenodo.6968924 (Almushayti et al., 2022).
Keys:

Type of study:
1- CT abdomen w/c
2- CT abdomen wo/c
3- CT abdomen & pelvis w/c
4- CT abdomen & pelvis wo/c
5- CT abdomen KUB
6- CT abdomen perfusion
7- CT abdomen for acute bowel ischemia

Date on month: Number of months.

Gender:
1- male
2- female

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