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ORIGINAL ARTICLE

Is There a Correlation between Computed Tomography Scanning of the Acute Abdomen and Associated Surgical Outcomes?

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ABSTRACT

Objectives: *To determine the correlation between computed tomography (CT) scanning in evaluating the acute abdomen and the associated surgical outcome.*

Methods: *This was a retrospective observational study of 362 patients (198 females, 164 males) admitted with an acute abdomen and underwent surgery to the Acute General Surgery and Colorectal Units at Dandenong District Hospital, Australia, between 1 January 2012 and 30 June 2012. Overall, 100 patients (case group) underwent an inpatient preoperative CT scan whereas 262 patients (control group) did not. Surgical outcome was compared between the case and control groups. In the case group, CT diagnosis was compared with the final surgical diagnosis to generate diagnostic performance parameters.*

Results: *CT scanning of the acute abdomen had an accuracy of 88%, sensitivity of 88%, and specificity of 100%. The most common cause of the acute abdomen in both case and control groups was appendicitis. The mean length of hospital stay was 4.0 days in the control group and 9.6 days in the case group. Surgical outcome was worst in the case group for patients aged over 31 years, although rates of reoperation and intensive care unit stay were higher in those aged over 60 years in the control group. Differences in surgical outcome were not statistically significant.*

Conclusion: *CT scanning of patients with an acute abdomen improves diagnostic performance and should be used as an adjunct to clinical evaluation if the benefits outweigh the risks. Surgical outcome in the acute abdomen is not influenced by preoperative CT scanning.*

Key Words: *Abdomen, acute; Length of stay; Tomography, X-ray computed*

中文摘要

急性腹症的電腦斷層掃描和有關手術結果之間是否相關？

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目的：急性腹症的電腦斷層（CT）掃描和有關手術結果的相關性。

方法：回顧研究於2012年1月1日至6月30日期間，因急腹症須接受手術而被送入澳洲Dandenong區醫院的急性外科和結腸直腸部的362名患者（164男、198女）。其中100人（實驗組）曾於術前接受CT掃描，其餘262人（對照組）未有CT掃描。比較兩組的手術結果及實驗組CT診斷和術後診斷以尋找診斷評價指標。

結果：急性腹部CT掃描的準確度為88%、靈敏度88%、特異性100%。實驗組和對照組最常見的腹痛

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原因是闌尾炎。平均住院期對照組為4.0天而實驗組為9.6天。實驗組中31歲以上的病人手術結果較差；對照組中60歲以上病人再手術率和入住深切治療病房的比率較實驗組高。兩組的手術結果並無統計顯著差異。

結論：替急腹症患者進行CT掃描可提高診斷準確性。如果進行CT掃描的益處高於風險，應視它為一種臨床輔助工具。但急腹症手術結果未因術前CT掃描而改變。

INTRODUCTION

Acute abdomen is defined as severe and acute abdominal pain due to various vascular, mechanical, or inflammatory causes. Acute abdomen warrants urgent assessment and often requires surgical intervention.

A computed tomography (CT) scan is considered the gold standard for assessing most causes of acute abdomen. Siewert et al[1] demonstrated that CT scanning was more sensitive (90%) than clinical evaluation (76%) in diagnosing acute abdomen, especially in those with no prior history of abdominal conditions. In addition, the duration of symptoms and signs of acute abdomen do not affect the sensitivity of CT scanning assessment.[1] Separate studies by Weir-McCall et al[2] and Taourel et al[3] have reported the accuracy of CT scanning in detecting the causes of acute abdomen to be 93% and 95%, respectively.

The use of CT in assessing the acute abdomen should be directed by clinical findings and, when used appropriately, improves the management plan and patient outcome.[4,5] Management plans have been noted to change in 30% to 50% of patients following a CT[3,6-8] and reduced the need for unnecessary laparotomy.[3,6] The rate of change in the leading diagnosis of acute abdominal cases from pre- to post-CT scanning varies widely; 50% was reported in a study by Abujudeh et al[8] and 13% in a study by Brown et al.[9] In patients with suspected acute appendicitis who underwent a CT scan, hospital admission rates were reduced in a quarter of cases.[10]

Despite the benefits of CT scans in assessing the acute abdomen, it should be used with care in pregnant women and young children due to the radiation risk.[11,12] Ultrasonography is recommended as the initial imaging modality with CT scans performed as an adjunct as this improves sensitivity and reduces radiation risk.[13,14] In addition, early CT scanning is an independent predictor of reduced mortality in emergency admissions[15] although there is no difference in length of hospital stay.[16]

No specific study evaluates the use of CT in assessing the acute abdomen and the associated surgical outcomes in Australia. The aim of this study was to determine the correlation between use of CT in evaluating the acute abdomen and the associated surgical outcomes in a metropolitan teaching hospital in Victoria, Australia.

METHODS

A retrospective observational study was conducted. No ethics approval was required for this study.

Participants

Between 1 January 2012 and 30 June 2012, 362 (198 females, 164 males) patients admitted with an acute abdomen to the Acute General Surgery and Colorectal Units at Dandenong Hospital in Australia, who then underwent surgery. All patients either presented with an acute abdomen on admission or developed an acute abdomen during admission. The case group (45 females, 55 males) underwent a preoperative CT scan whereas the control group (153 females, 109 males) did not. The control group either underwent an alternative imaging modality (e.g. ultrasonography) or no imaging. The terms 'case' and 'control' here are used for ease of reference and do not actual imply a randomised trial. Exclusion criteria included patients who had imaging performed elsewhere.

Data Collection and Analysis

All patient data were obtained electronically from the WebQI electronic data system (ISS, Victoria, Australia) and Scanned Medical Records. CT scan data were obtained from Centricity PACS system (GE Healthcare, United Kingdom). Data were entered into Microsoft Excel (Microsoft Corporation, Redmond [WA], USA) workbooks.

Data analysis was conducted in two parts. First, radiological diagnoses (confirmed by a senior radiologist) were compared with the final surgical diagnoses in order to generate case verdicts: true positive, true negative, false positive, and false negative.

Table 1. Comparison of diagnostic performance parameters pre- and post-CT scanning in the 'case' group (n = 100).

	Accuracy	Sensitivity	Specificity	PPV	NPV
Pre-CT scanning	0.75	0.76	0.00	0.99	0.00
Post-CT scanning	0.88	0.88	1.00	1.00	0.08

Abbreviations: CT = computed tomography; NPV = negative predictive value; PPV = positive predictive value.

The case verdicts were used to calculate diagnostic performance parameters (accuracy, sensitivity, specificity, positive predictive value [PPV], and negative predictive value [NPV]). Similar data analysis was conducted comparing clinical diagnoses of pre-CT scanning with final surgical diagnoses. Diagnostic performance parameters were compared for pre- and post-CT scanning within the case group.

The second part of the analysis involved comparison of the surgical outcomes (complications, length of hospital stay, morbidity and mortality associated with the surgery) for patients who underwent CT scans preoperatively (case group) with those who did not (control group). Any difference observed in the complication rate between the case and control groups was considered statistically significant if the p value generated from the Student's *t*-test was <0.05.

RESULTS

As shown in Table 1, CT scanning of the acute abdomen in our study had an accuracy of 88%, sensitivity of 88%, and specificity of 100%. In comparison, clinical evaluation (pre-CT scanning) of the acute abdomen yielded an accuracy of 75%, sensitivity of 76%, and specificity of 0%. PPV and NPV were also higher in post-CT scanning compared with pre-CT scanning.

Table 2 shows the breakdown of diagnoses in both the case and control groups. The predominant diagnosis in both groups was appendicitis: 39 (out of 100) and 128 (out of 262) cases, respectively. The second and third most common diagnosis was bowel obstruction (18 cases) and perforated viscus (16 cases) in the case group, and cholecystitis / cholelithiasis (58 cases) and ovarian / uterine pathology (23 cases) in the control group.

Surgical complications were higher in the case group compared with the control group across most age-groups except those >60 years old (Table 3). In those >60 years of age, mortality rate, readmission rate, rates of ileus and wound infections were higher in the case group compared with the control group. Reoperation rate and rate of intensive care unit (ICU) stay were higher in the control group for patients aged >60 years. Surgical outcome was better (zero complication rate) in the lower age-group (<31 years old) for patients in both case and control groups. These differences were not statistically significant ($p > 0.05$).

Table 2. Distribution of patients in 'case' and 'control' groups by surgical diagnosis.

Surgical diagnosis	No. of patients	
	'Case' group	'Control' group
Bowel obstruction	18	11
Appendicitis	39	128
Perforated viscus	16	5
Cholecystitis / cholelithiasis	10	58
Necrotic bowel	3	1
Hernia	6	6
Intra-abdominal abscess	2	2
Colitis / diverticulitis	2	3
Ovarian / uterine pathology	1	23
Haematoma	1	0
Pelvic inflammatory disease	1	0
Normal	1	19
Serositis	0	1
Mesenteric adenitis	0	5
Total	100	262

Those in the control group were hospitalised for a mean of 4.0 days compared with 9.6 days in the case group. The majority of patients (48%) who underwent preoperative CT scanning were >60 years old whereas the majority of those (34%) who did not were in the 21-30 years' age-group (Figure).

The mean time between admission and CT scanning was 1.33 days. This was relatively short and implied that most patients underwent CT scanning very soon after admission.

DISCUSSION

The diagnostic performance parameters in our study were similar to those quoted by previous studies.[1-3] We demonstrate that CT scanning of the acute abdomen improves diagnostic performance. In patients who are acutely unwell, however, CT scanning should not delay

Table 3. Complication rate by age-group and associated p value.

Age-group (years)		%					
		Mortality	Readmission	Reoperation	Ileus	Wound infection	ICU stay
≤20	Case	0	0	0	0	0	0
	Control	0	0	0	0	0	0
21-30	Case	0	0	0	0	0	0
	Control	0	0	0	0	0	0
31-40	Case	0	0	20	0	0	20
	Control	0	0	0	0	0	0
41-50	Case	0	6	6	0	0	19
	Control	0	0	0	0	0	3
51-60	Case	10	0	0	20	0	5
	Control	0	0	0	0	0	0
>60	Case	17	4	4	10	8	27
	Control	14	0	7	0	7	28
Mean	Case	5	2	5	5	1	12
	Control	2	0	1	0	1	5
p Value		0.24	0.19	0.44	0.20	0.36	0.13

Abbreviation: ICU = intensive care unit.

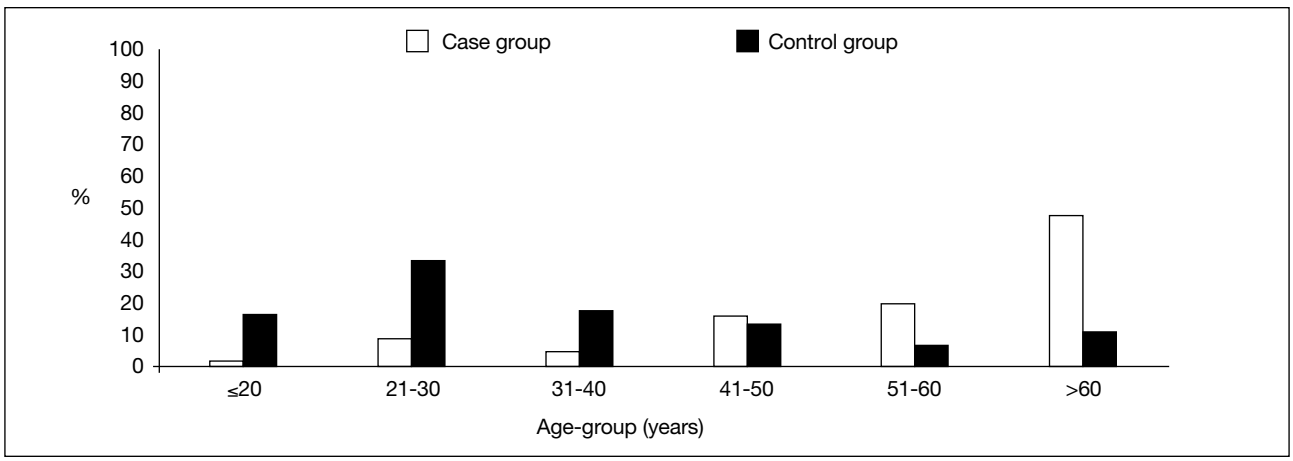

Figure. Percentage of patients in case and control groups stratified by age.

commencement of treatment, be it medical or surgical. In our study, CT scanning was the modality of choice in assessing most causes of acute abdomen, i.e. bowel obstruction and perforated viscus. Nonetheless, other non-radiating imaging modalities (e.g. ultrasonography) were preferred when assessing other common causes for acute abdomen — appendicitis, biliary and gynaecological pathology. This was because in our patient population, these diagnoses tend to be associated with younger patients who are of reproductive age. The use of ultrasonography as the first-line imaging modality in young patients has been documented extensively in the literature.[16-18] Ionising radiation is avoided in this population due to their increased radiosensitivity. Therefore, we recommend CT scanning as the imaging of choice in evaluating the acute abdomen but used with caution in certain populations, such as younger patients and pregnant patients.

The length of hospital stay for patients with an acute abdomen who underwent CT scanning was longer than those who did not undergo CT scanning. This was unlikely to be related to the scan or surgery but to the population being studied. The majority of patients in our case group were aged over 60 years and had more comorbidities than the control group. This group was therefore more likely to require a longer inpatient stay. In comparison, the control group comprised mainly individuals aged 21-30 years. This relatively younger age-group had fewer comorbidities and therefore a

shorter hospital stay. There was clearly a tendency to perform preoperative CT scans in older patients, particularly in those with a clinical diagnosis of appendicitis.

Surgical outcome was worst in the case group for patients aged >31 years. Reoperation rate and rate of ICU stay, however, were higher in patients aged >60 years within the control group. As these differences were not statistically significant, it was most likely normal variation in data.

The time between admission and CT scanning was relatively short. This is likely because CT is a quick, easily accessible, and preferable modality to assist patient diagnosis and therefore, directing patient management. Although CT scanning aids diagnosis and assists with clinical planning, it should only be used if the benefits outweigh the risk. This fits with the theme of justification, which is one of the pillars of radiation protection. CT provides important information that assists the clinician but should not be used to replace clinical history-taking and examination.[19]

The study was limited by the availability of electronic data. This limited the sample size and statistical power of the study. Further research into the benefits and risks of CT scans in assessing the acute abdomen is warranted. A larger sample size and a risk-adjusted randomised control trial would provide a higher-powered study. This would assist formation of guidelines on the role of CT scans in acute abdominal cases.

CONCLUSION

CT scanning of the acute abdomen improves diagnostic performance and should be used as an adjunct to clinical evaluation if the benefits outweigh the risks. Surgical outcome of the acute abdomen is not influenced by CT scanning.

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REFERENCES

1. Siewert B, Raptopoulos V, Mueller MF, Rosen MP, Seer M. Impact of CT on diagnosis and management of acute abdomen in patients initially treated without surgery. AJR Am J Roentgenol. 1997;168:173-8. cross ref
2. Weir-McCall J, Shaw A, Arya A, Knight A, Howlett DC. The use of pre-operative computed tomography in the assessment of the acute abdomen. Ann R Coll Surg Engl. 2012;94:102-7. cross ref
3. Taourel P, Baron MP, Pradel J, Fabre JM, Seneterre E, Bruel JM. Acute abdomen of unknown origin: impact of CT on diagnosis and management. Gastrointest Radiol. 1992;17:287-91. cross ref
4. Salem TA, Molloy RG, O'Dwyer PJ. Prospective study on the role of the CT scan in patients with an acute abdomen. Colorectal Dis. 2005;7:460-6. cross ref
5. Tsushima Y, Yamada S, Aoki J, Motojima T, Endo K. Effect of contrast-enhanced computed tomography on diagnosis and management of acute abdomen in adults. Clin Radiol. 2002;57:507-13. cross ref
6. Chambers A, Halligan S, Goh V, Dhillon S, Hassan A. Therapeutic impact of abdominopelvic computed tomography in patients with acute abdominal symptoms. Acta Radiol. 2004;45:248-53. cross ref
7. Rosen MP, Sands DZ, Longmaid HE 3rd, Reynolds KF, Wagner M, Raptopoulos V. Impact of abdominal CT on the management of patients presenting to the emergency department with acute abdominal pain. AJR Am J Roentgenol. 2000;174:1391-6. cross ref
8. Abujudeh HH, Kaewlai R, McMahon PM, Binder W, Novelline RA, Gazelle GS, et al. Abdominopelvic CT increases diagnostic certainty and guides management decisions: a prospective investigation of 584 patients in a large academic medical center. AJR Am J Roentgenol. 2011;196:238-43. cross ref
9. Brown DF, Fischer RH, Novelline RA, Kim J, Nagurney JT. The role of abdominal computed tomography scanning in patients with non-traumatic abdominal symptoms. Eur J Emerg Med. 2002;9:330-3. cross ref
10. Rosen MP, Siewert B, Sands DZ, Bromberg R, Edlow J, Raptopoulos V. Value of abdominal CT in the emergency department for patients with abdominal pain. Eur Radiol. 2003;13:418-24.
11. Grammaticos P, Fountos G. The physician should benefit, not harm the patient. Hell J Nucl Med. 2006;9:82-4.
12. Saito JM. Beyond appendicitis: evaluation and surgical treatment of pediatric acute abdominal pain. Curr Opin Pediatr. 2012;24:357-64. cross ref
13. Hernandez JA, Swischuk LE, Angel CA, Chung D, Chandler R, Lee S. Imaging of acute appendicitis: US as the primary imaging modality. Pediatr Radiol. 2005;35:392-5. cross ref
14. Laméris W, van Randen A, van Es HW, van Heesewijk JP, van Ramshorst B, Bouma WH, et al. Imaging strategies for detection of urgent conditions in patients with acute abdominal pain: diagnostic accuracy study. BMJ. 2009;338:b2431. cross ref
15. Symons NR, Moorthy K, Almoudaris AM, Bottle A, Aylin P, Vincent CA, et al. Mortality in high-risk emergency general surgical admissions. BMJ. 2013;100:1318-25. cross ref
16. Sala E, Watson CJ, Beadsmoore C, Groot-Wassink T, Fanshawe TR, Smith JC, et al. A randomized, controlled trial of routine early abdominal computed tomography in patients presenting with non-specific acute abdominal pain. Clin Radiol. 2007;62:961-9. cross ref
17. Abdelhalim MA, Stuart JD, Nicholson GA. Augmenting the decision making process in acute appendicitis: A retrospective cohort study. Int J Surg. 2015;17:5-9. cross ref
18. Bachar I, Perry ZH, Dukhno L, Mizrahi S, Kirshtein B. Diagnostic value of laparoscopy, abdominal computed tomography, and ultrasonography in acute appendicitis. J Laparoendosc Adv Surg Tech A. 2013;23:982-9. cross ref
19. Lee SL, Walsh AJ, Ho HS. Computed tomography and ultrasonography do not improve and may delay the diagnosis and treatment of acute appendicitis. Arch Surg. 2001;136:556-62. cross ref