

Prevalences of Incidental Findings in Trauma Patients by Abdominal and Pelvic Computed Tomography

Jin Young Lee, M.D., Myung Jae Jung, M.D., Jae Gil Lee, M.D., Ph.D., Seung Hwan Lee, M.D.

Department of Surgery, Yonsei University College of Medicine, Seoul, Korea

Purpose: Abdominal and pelvic computed tomography (APCT) is frequently used as a diagnostic tool in trauma patients. However, trauma unrelated, incidental findings are frequently encountered. The aim of this study was to determine the prevalences of incidental findings on APCT scans in trauma patients.

Methods: The archived records of 801 trauma patients treated from January 2013 to December 2015 were reviewed retrospectively. Six hundred and forty of these patients underwent contrast enhanced APCT in an emergency department and were included in this study, and 205 (32.1%) of these patients had incidental findings. These findings were divided into two categories: category I, meaning a radiological benign finding not requiring further evaluation or follow-up, and category II, requiring further evaluation and follow-up.

Results: One hundred and sixty (24.8%) patients were allocated to category I and 45 (7.2%) to category II. The most frequent incidental findings were discovered in kidneys (34.6%), followed by liver (28.8%), and gallbladder (15.6%). The most frequent finding in category I was a benign cyst (60.1%), followed by a simple stone (15.6%), and hemangioma (11.9%). Adenomyomatosis of the gallbladder (17.8%) was the most common lesion in category II, followed by atypical mass (15.6%), complicated stone (15.6%) and cystic neoplasm (15.6%).

Conclusion: The prevalence of an incidental finding on APCT scans was 32.1%. Although category II lesions were not common in trauma patients, these findings should be communicated to patients, and when necessary referred to a primary care physician. Systems are required for producing appropriate discharge summaries and informing patients about the implications of incidental findings. [J Trauma Inj 2016; 29: 61-67]

Key Words: Incidental findings, Trauma, Abdominal and pelvic computed tomography (APCT)

I. Introduction

The first commercially viable computed tomography (CT) scanner was installed in Atkinson Morley Hospital in Wimbledon, England in 1971,(1) and since CT technology has vastly improved in speed, slice count, and image quality. Multidetector CT (MDCT) is able to decrease scan times to less than a minute, and obtain high quality images that of less than 1 mm slices.(2) Due to these benefits, CT has become the

preferred means for the initial evaluation of trauma patients.(3-5)

The increased use of CT has not only improved the immediate diagnosis of injury, but it has also increased detection of incidental findings (IFs).(6-9) These IFs may be beneficial to patients, for example, they may result in the early detection of a significant pathology, but they also increase anxiety and health-care costs because of additional investigations undertaken.(10) Many reports have been issued regarding

* Address for Correspondence : **Seung Hwan Lee, M.D.**

Department of Surgery, Yonsei University College of Medicine,

50-1 Yonsei-ro, Seodaemun-gu, Seoul 03722, Korea

Tel : 82-2-2228-2108, Fax : 82-2-313-8289, E-mail : seunghwan@yuhs.ac

Submitted : July 7, 2016 **Revised** : July 13, 2016 **Accepted** : September 12, 2016

This study was not funded and the authors have no potential conflict of interest to declare.

the clinical implications of IFs in non-trauma patients,(11-13) and the presence of incidental CT findings in trauma patients has been documented on several occasions.(6-9,14-16) Furthermore, the need for further diagnostic work-up, referral, and treatment is difficult for trauma surgeons to determine,(15) and may have serious consequences. Currently, the work-up of IFs varies between clinicians and regions, and no well-established classification exists.(6,7,17)

We performed this study to document the frequency of IF detection by abdominal and pelvic computed tomography (APCT) and to determine how many follow-ups were performed in these patients.

II. Materials and Methods

1. Study design and population

This retrospective observational study was conducted at a single center from January 2013 to December 2015. During this period 801 trauma patients were admitted to emergency department. Six hundred and forty of these patients that underwent

APCT were enrolled in the present study, and divided into two groups: the group with IFs (the IF group; n=205) and the group without IFs (the non-IF group; n=435). The IF group was subdivided into category I (finding not followed; n=160) and category II (finding followed; n=45) (Fig. 1).

A trauma surgeon determined whether a CT scan was required after the patient had undergone an initial primary survey. CT images were immediately reviewed by a senior resident radiologist, and a final reading was subsequently issued by the staff radiologist several days later.

The study was approved by our Institutional Review Board (IRB No. 4-2016-0293), which waived the requirement for informed consent because of the retrospective nature of the study.

2. Variables and definitions

The baseline characteristics included were: age, sex, hospital stay, intensive care unit (ICU) stay, trauma related variables, such as, injury mechanism, injury region, injury severity score (ISS), revised trauma score (RTS), trauma and injury severity score (TRISS),

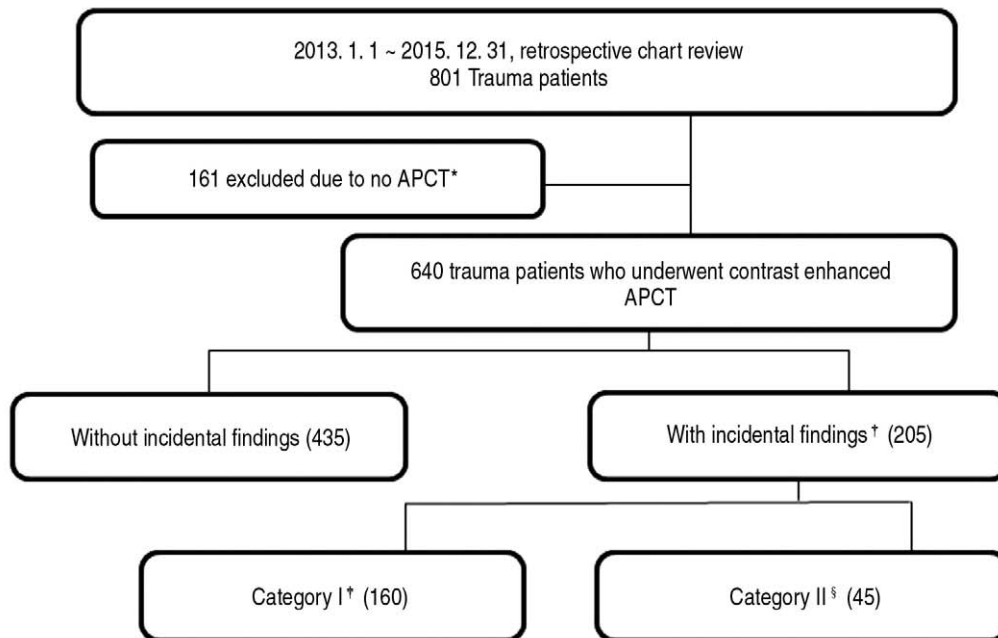


Fig. 1. Study protocol.

* APCT: Abdominal and pelvic computed tomography

† Incidental findings: findings on APCT unrelated to the injury identified by formal radiologic reading

‡ Category I: radiologically benign - no need for further evaluation or follow-up

§ Category II: requiring further evaluation and follow-up

and mortality.

IFs were defined as findings on APCT, confirmed by formal reading, are unrelated to traumatic injury. Using previously described classifications,(6,7,15,18) IFs were classified into two categories. Category I was defined as radiological benign requiring no further evaluation or follow-up, e.g., a simple cyst or tiny simple stone, and category II defined a pathology concern, such as, adrenal adenoma or a large (>2 cm) or impacted stones, requiring further evaluation, follow-up, and treatment. One investigator independently categorized incidental findings according to these definitions, and then another investigator confirmed these assignments. Disagreements were discussed and resolved by consensus with other investigators.

3. Statistical analysis

Statistical analysis was performed using IBM SPSS Statistics ver. 20.0 (IBM Co. Armonk, NY). The

baseline and clinical characteristics of patients in the IF and non-IF groups were compared by univariate analysis. The anatomical distributions and subgroups of IFs were compared using numbers of IFs and not patient numbers. Categorical data are presented as numbers (%) and were compared using the Chi-square or Fisher's exact test. Continuous variables are expressed as means and standard deviations or medians and inter-quantile ranges (IQR), and intergroup comparisons were conducted using the Student's t-test or the Mann-Whiney U test. Statistical significance was accepted for *p* value<0.05.

III. Results

Median age of the 640 study subjects was 48 years, and 27% were women. Median age in the IF group was significantly greater than in the non-IF group (56 vs. 41 years), and the proportion of women

Table 1. Baseline characteristics of all study subjects and of patient groups

	Total (640)	IF (435)	non-IF (205)	<i>p</i> value
Age, median (IQR) [†]	48 (29.0-62.0)	41 (26.0-59.0)	56 (41.0-67.0)	< 0.001
Female, n (%)	176 (27.5)	108 (24.8)	68 (33.2)	0.029
Mechanism of injury, n (%)				0.013
Pedestrian	179 (28.0)	107 (24.6)	72 (35.1)	
In car TA	102 (15.9)	65 (14.9)	37 (18.0)	
Motorcycle	148 (23.1)	117 (26.9)	31 (15.1)	
Bicycle	18 (2.8)	14 (3.2)	4 (2.0)	
Fall down	143 (22.3)	97 (22.3)	46 (22.4)	
Penetrating	27 (4.2)	20 (4.6)	7 (3.4)	
Etc.	23 (3.6)	15 (3.4)	8 (3.9)	
Injury region, n (%)				
Head & Neck	378 (59.1)	252 (58.9)	126 (61.8)	0.544
Face	187 (29.2)	127 (29.7)	60 (29.4)	1.000
Chest	253 (39.5)	172 (40.2)	81 (39.7)	0.931
Abdomen	215 (33.6)	162 (37.9)	53 (26.0)	0.004
Extremities	332 (51.9)	229 (53.5)	103 (50.5)	0.496
External	442 (69.1)	319 (73.3)	123 (60.0)	0.001
ISS, mean ± 2SD.	14.4 ± 10.8	14.8 ± 11.2	13.5 ± 10.0	0.159
RTS	7.205 ± 1.456	7.155 ± 1.562	7.311 ± 1.199	0.167
TRISS	91.8 ± 18.93	91.1 ± 20.50	93.3 ± 14.99	0.138
LoH*, day median (IQR) [†]	17.7 (4.0-37.8)	6.0 (1.0-18.0)	5.0 (1.0-17.0)	0.785
LoICU [‡] , day	4.0 (2.0-9.8)	4.0 (2.0-9.3)	4.0 (2.0-12.0)	0.686
Mortality, n (%)	50 (7.8)	30 (6.9)	20 (9.8)	0.269

* LoH: Length of hospital stay

[†] IQR: Inter-quartile range

[‡] LoICU: Length of intensive care unit stay

was significant higher in the IF group (33.2% vs. 24.8%, respectively). Trauma related variables, length of hospital stays and mortalities were not significantly different between these two groups (Table 1). No significant differences were observed

between the baseline characteristics of categories I and II (Table 2).

IFs were most frequently discovered in kidneys (34.6%), followed by liver (28.8%), and gallbladder (15.6%). Similarly, kidneys (41.9%) were most fre-

Table 2. Comparison of baseline characteristics of patients with category I and II

	Category I (160)	Category II (45)	<i>p</i> value
Age, median (IQR) [†]	56 (42-67)	55 (41-68)	0.951
Female, n (%)	54 (34.0)	14 (30.4)	0.724
Mechanism of injury, n (%)			0.621
Pedestrian	56 (35.2)	16 (34.8)	
In car TA	26 (16.4)	11 (23.9)	
Motorcycle	26 (16.4)	5 (10.9)	
Bicycle	4 (2.5)	0 (0.0)	
Fall down	37 (23.3)	9 (19.6)	
Penetrating	5 (3.1)	2 (4.3)	
Etc.	5 (3.1)	3 (6.5)	
Injury region, n (%)			
Head & Neck	98 (61.6)	28 (62.2)	1.000
Face	45 (28.3)	15 (33.3)	0.579
Chest	61 (38.4)	20 (44.4)	0.493
Abdomen	41 (25.8)	12 (26.7)	1.000
Extremities	80 (50.3)	23 (51.1)	1.000
External	94 (59.1)	29 (63.0)	0.733
ISS, mean ± 2SD	13.3 ± 9.5	14.5 ± 11.6	0.480
RTS	7.379 ± 0.977	7.076 ± 1.760	0.269
TRISS	94.7 ± 11.0	88.4 ± 23.7	0.086
LoH, median (IQR)	5.3 (1.0-16.8)	5.0 (1.8-18.5)	0.858
LoICU	4.0 (2.0-14.0)	2.5 (2.0-7.5)	0.202
Mortality, n (%)	13 (8.2)	7 (15.2)	0.165
Follow-up, n (%)		9 (23.0) [§]	

[†] IQR: Inter-quartile range

[§] 9 (23.0): excluding patients that expired or transferred.

Table 3. Anatomical distributions and frequencies of incidental findings in categories I and II

	Total (IF group; 238)	Category I (184)	Category II (52)	<i>p</i> value
Kidney	71 (34.6)	67 (41.9)	4 (8.7)	< 0.001
Liver	59 (28.8)	47 (29.4)	12 (26.7)	0.853
Gallbladder	32 (15.6)	18 (11.2)	14 (31.1)	0.002
Uterus with adnexa	17 (8.3)	15 (9.4)	2 (4.4)	0.373
Intestine	13 (6.3)	8 (5.0)	5 (11.1)	0.165
Urinary tract with bladder	13 (6.3)	9 (5.6)	2 (8.9)	0.488
Pancreas	10 (4.9)	6 (3.8)	4 (8.9)	0.231
Adrenal gland	9 (4.4)	4 (2.5)	5 (11.1)	0.026
Bone	4 (2.0)	3 (1.9)	1 (2.2)	1.000
Vascular	4 (2.0)	1 (0.6)	3 (6.7)	0.034
Others	6 (6.0)	6 (3.8)	0 (0.0)	0.343

Data are presented in number (%).

quent in category I also followed by liver (29.4%), and gallbladder (11.2%). However, in category II, IFs were commonly discovered in gallbladder (31.1%) followed by liver (26.7%) and the gastro-intestinal tract or the adrenal gland (Table 3).

The most frequent finding in category I was a benign cyst (60.1%), followed by simple stone (15.6%), and hemangioma (11.9%). Other findings in category I were diverticulum (5.0%), hyperplasia (4.4%), and hemangioma (11.9%). Adenomyomatosis of gallbladder (17.8%) was most common in category II, followed atypical mass (15.6%), complicated stone (15.6%), and cystic neoplasm (15.6%) (Table 4). Malignancy was found in 2 patients, namely, hepatocellular carcinoma and prostate cancer.

IV. Discussion

In this study, 32% of trauma patients (n=205) evaluated by APCT had at least one IF, which concurs with previously reported rates.(6-9) One hundred and sixty patients (24.8%) were classified as category I, and 45 (7.2%) patients as category II. Only 9 (23%) patients in category II were followed-up or further evaluated.

Previous studies,(6,16) have shown that CT IF rates increase with age, and the present study adds weight to this association, and median age was greater in the IF group than in the non-IF group. However, median ages in category I and II were not significantly different. Elderly patients becoming more active, and thus, are experiencing severe injuries more often, which explains, at least in part, the increasing detection of IFs.(19) Furthermore, given similar injury severities, mortality appears to

be higher among older patients,(20) and hence, these patients need more careful examinations and longer observations.

Adenomyomatosis may be seen in as many as 9% of cholecystectomy specimens, and accounts for - 25% of all polypoid lesions in the gallbladder.(21,22) Furthermore, detection rates increase with age and are higher for women.(23) The current view is that adenomyomatosis is not a premalignant condition,(21,23,24) but it is difficult to differentiate focal adenomyomatosis and malignancy, and to make matters worse adenocarcinoma of the gallbladder can occur in localized adenomyomatosis.(25) For this reason, we classified adenomyomatosis as category II in the present study. Furthermore, it was the most frequently detected IF in this category.

IFs increase the workload of trauma surgeons, because they are not primary physicians. The treatment of trauma patients is complex, and the management of trauma injuries is prioritized, and during initial trauma care, many IFs might be unimportant. Trauma care is based on rapid diagnosis and treatment, and most injuries do not lead to permanent disability or require long-term follow-up. On the other hand, non-traumatic diagnoses often require a less aggressive approach, and the early identification and treatment of some IFs not only increases patient survival but also decreases morbidity.(18,26,27) Although the optimal management of patients with many types of IFs remains a topic of discussion, system is required to include incidental CT findings on discharge summaries and to inform patients of these findings and their implications. In a previous study, it was reported that only 48% of patients with serious findings had any documenta-

Table 4. Description of subgroups in Categories I and II

	Category I (177)		Category II (45)
Benign cyst	96 (60.1)	Adenomyomatosis	8 (17.8)
Simple stone	25 (15.6)	Stone (complicated)	7 (15.6)
Hemangioma	19 (11.9)	Cystic Neoplasm	7 (15.6)
Hyperplasia	7 (4.4)	Atypical mass	7 (15.6)
Myoma	7 (4.4)	Adenoma	6 (13.3)
Lipoma	3 (1.9)	Aneurysm	3 (6.7)
Diverticulum	8 (5.0)	Malignancy	2 (4.4)
Others	12 (7.5)	Others	5 (11.1)

Data are presented in number (%).

tion of treatment or scheduled follow-up.(28) In the present study, we found that only 23% (n=9) of patients in category II were followed up or further evaluated, although it is possible patients with IFs were given verbal follow-up instructions, and that these were not recorded in discharge summaries.

The present study has several limitations that require consideration. First, the study involved a single-center, retrospective chart review, and thus, its results may not be applicable to all hospitals. Furthermore, it is possible our regional patient population had different health risk factors that increased the risks of cancer, and cardiovascular, and cerebrovascular disease. Second, APCT was performed because of trauma, and thus, the radiologists focused on traumatic injuries and not on other anomalies. Third, the clinical significances of IFs were assessed retrospectively based on the presumed need for follow-up and thus, the classification used was highly subjective. Fourth, we did not investigate the management or outcomes of IFs and thus were unable to access the risks or benefits of our findings. We recommended that follow-up study be conducted to investigate these issues.

V. Conclusion

The use of APCT for the evaluating trauma patients has generated a large number of IFs (32%). In the present study, category II (requiring further evaluation and follow-up) constituted 7.2% (n=45) of the 640 study subjects. We believe such findings should be communicated to patients and that when appropriate some patients be referred to primary care physicians. Furthermore, according to our records, follow-up of these patients was poor, which demonstrates a system that adds this information to discharge summaries and ensures patients are adequately informed is urgently required.

VI. Acknowledgements

Authors' contributions: JYL and SHL designed the study, JYL collected the data, JYL did the statistical analyses with SHL, JGL and MJJ. JYL wrote the article. All authors read and approved the submitted version.

REFERENCES

- 1) Beckmann EC. CT scanning the early days. *Br J Radiol* 2006; 79: 5-8.
- 2) Prokop M. General principles of MDCT. *Eur J Radiol* 2003; 45: S4-10.
- 3) Salim A, Sangthong B, Martin M, Brown C, Plurad D, Demetriades D. Whole body imaging in blunt multisystem trauma patients without obvious signs of injury: results of a prospective study. *Arch Surg* 2006; 141: 468-73; discussion 73-5.
- 4) Sampson MA, Colquhoun KB, Hennessy NL. Computed tomography whole body imaging in multi-trauma: 7 years experience. *Clin Radiol* 2006; 61: 365-9.
- 5) Wisbach GG, Sise MJ, Sack DI, Swanson SM, Sundquist SM, Paci GM, et al. What is the role of chest X-ray in the initial assessment of stable trauma patients? *J Trauma* 2007; 62: 74-8; discussion 8-9.
- 6) Paluska TR, Sise MJ, Sack DI, Sise CB, Egan MC, Biondi M. Incidental CT findings in trauma patients: incidence and implications for care of the injured. *J Trauma* 2007; 62: 157-61.
- 7) Barrett TW, Schierling M, Zhou C, Colfax JD, Russ S, Conatser P, et al. Prevalence of incidental findings in trauma patients detected by computed tomography imaging. *Am J Emerg Med* 2009; 27: 428-35.
- 8) Ekeh AP, Walusimbi M, Brigham E, Woods RJ, McCarthy MC. The prevalence of incidental findings on abdominal computed tomography scans of trauma patients. *J Emerg Med* 2010; 38: 484-9.
- 9) Munk MD, Peitzman AB, Hostler DP, Wolfson AB. Frequency and follow-up of incidental findings on trauma computed tomography scans: experience at a level one trauma center. *J Emerg Med* 2010; 38: 346-50.
- 10) Berlin L. Potential legal ramifications of whole-body CT screening: taking a peek into Pandora's box. *AJR Am J Roentgenol* 2003; 180: 317-22.
- 11) Elgin EE, O'Malley PG, Feuerstein I, Taylor AJ. Frequency and severity of "incidentalomas" encountered during electron beam computed tomography for coronary calcium in middle-aged army personnel. *Am J Cardiol* 2002; 90: 543-5.
- 12) Hunold P, Schmermund A, Seibel RM, Gronemeyer DH, Erbel R. Prevalence and clinical significance of accidental findings in electron-beam tomographic scans for coronary artery calcification. *Eur Heart J* 2001; 22: 1748-58.
- 13) Messersmith WA, Brown DF, Bary MJ. The prevalence and implications of incidental findings on ED abdominal CT scans. *Am J Emerg Med* 2001; 19: 479-81.
- 14) van Vugt R, Dekker HM, Deunk J, van der Vijver RJ, van Vugt AB, Kool DR, et al. Incidental Findings on Routine Thoracoabdominal Computed Tomography in Blunt Trauma Patients. *J Trauma* 2011.
- 15) Ruessler M, Schill A, Lehnert T, Wyen H, Wutzler S, Marzi I, et al. Incidental findings in patients with multiple injuries: how to proceed? *J Trauma Acute Care Surg* 2013; 75: 848-53.

- 16) Seah MK, Murphy CG, McDonald S, Carrothers A. Incidental findings on whole-body trauma computed tomography: Experience at a major trauma centre. *Injury* 2016; 47: 691-4.
- 17) Berland LL, Silverman SG, Gore RM, Mayo-Smith WW, Megibow AJ, Yee J, et al. Managing incidental findings on abdominal CT: white paper of the ACR incidental findings committee. *J Am Coll Radiol* 2010; 7: 754-73.
- 18) Iezzi R, Cotroneo AR, Filippone A, Di Fabio F, Merlino B, Bonomo L. Extravascular incidental findings at multislice CT angiography of the abdominal aorta and lower extremity arteries: a retrospective review study. *Abdom Imaging* 2007; 32: 489-94.
- 19) Wutzler S, Lefering R, Laurer HL, Walcher F, Wyen H, Marzi I. [Changes in geriatric traumatology. An analysis of 14,869 patients from the German Trauma Registry]. *Unfallchirurg* 2008; 111: 592-8.
- 20) Tornetta P, 3rd, Mostafavi H, Riina J, Turen C, Reimer B, Levine R, et al. Morbidity and mortality in elderly trauma patients. *J Trauma* 1999; 46: 702-6.
- 21) Gallahan WC, Conway JD. Diagnosis and management of gallbladder polyps. *Gastroenterol Clin North Am* 2010; 39: 359-67.
- 22) Ootani T, Shirai Y, Tsukada K, Muto T. Relationship between gallbladder carcinoma and the segmental type of adenomyomatosis of the gallbladder. *Cancer* 1992; 69: 2647-52.
- 23) Mellnick VM, Menias CO, Sandrasegaran K, Hara AK, Kiellar AZ, Brunt EM, et al. Polypoid Lesions of the Gallbladder: Disease Spectrum with Pathologic Correlation-Erratum. *Radiographics* 2015; 35: 1316.
- 24) Kim JH, Jeong IH, Han JH, Kim JH, Hwang JC, Yoo BM, et al. Clinical/pathological analysis of gallbladder adenomyomatosis; type and pathogenesis. *Hepatogastroenterology* 2010; 57: 420-5.
- 25) Aldridge MC, Gruffaz F, Castaing D, Bismuth H. Adenomyomatosis of the gallbladder. A premalignant lesion? *Surgery* 1991; 109: 107-10.
- 26) Eskandary H, Sabba M, Khajehpour F, Eskandari M. Incidental findings in brain computed tomography scans of 3000 head trauma patients. *Surg Neurol* 2005; 63: 550-3; discussion 3.
- 27) Shetty SK, Maher MM, Hahn PF, Halpern EF, Aquino SL. Significance of incidental thyroid lesions detected on CT: correlation among CT, sonography, and pathology. *AJR Am J Roentgenol* 2006; 187: 1349-56.
- 28) Semelka RC, Armao DM, Elias J, Jr., Huda W. Imaging strategies to reduce the risk of radiation in CT studies, including selective substitution with MRI. *J Magn Reson Imaging* 2007; 25: 900-9.