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ORIGINAL ARTICLE

Low-Dose Abdominal CT for Evaluating Suspected Appendicitis

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Background

- CT has assumed a paramount position in the evaluation of adults with suspected appendicitis.
- Radiation exposure from CT is of particular concern in children or young adults.
- Reducing the radiation dose by 50 to 80% does not significantly hinder the diagnosis of appendicitis.

Methods

- noninferiority, single-institution, randomized trial.
- Patients 15 to 44 years of age who were undergoing CT examination for suspected appendicitis
- Emergency department physicians on service that led to the clinical suspicion of appendicitis

Methods

- CT scanners with 16, 64, or 256 detector rows (2 mSv in the low-dose group and 8 mSv in the standard-dose group)
- CT reports were initially prepared by one of three expert radiologists(day time)
- on-call radiologists during after hours
- An additional imaging test was defined as one performed within 7 days after the initial CT examination

Methods

- Final diagnosis was made on the basis of surgical and pathological findings.
- If not OP : medical records and telephone interviews 3 months after the patient's initial presentation
- Fisher's exact tests, Mann-Whitney U tests, and receiver-operating-characteristic analysis --- for analysis

Methods

- Primary end point : rate of negative appendectomy
- Secondary end points :
 - Rate of appendiceal perforation
 - proportion of patients who required additional imaging tests
 - the interval between acquisition of the CT images
 - nonincidental appendectomy or hospital discharge without surgery
 - Nonincidental appendectomy or hospital discharge without surgery
 - The length of the hospital stay associated with the appendectomy



September 2009 through January 2011

Table 1. Baseline Characteristics of the Patients.*

Characteristic	Low-Dose CT Group (N=444)	Standard-Dose CT Group (N=447)
Age — yr		
Median	29	30
Interquartile range	22–36	22–37
Sex — no. (%)		
Female	276 (62.2)	263 (58.8)
Male	168 (37.8)	184 (41.2)
Body-mass index — no. (%)†		
<18.5 (underweight)	42 (9.4)	60 (13.4)
18.5–24.9 (normal)	312 (70.3)	301 (67.3)
25.0–29.9 (overweight)	67 (15.1)	76 (17.0)
30.0–34.9 (class I obesity)	3 (0.7)	9 (2.0)
35.0–39.9 (class II obesity)	0	1 (0.2)
≥40.0 (class III obesity)	0	0
Chief symptom — no. (%)		
Abdominal pain	423 (94.8)	430 (96.2)
Other	21 (5.2)	17 (3.8)
Duration of symptoms — no. (%)		
≤12 hr	157 (35.4)	151 (33.8)
13–24 hr	167 (37.6)	158 (35.3)
2–3 days	84 (18.9)	101 (22.6)
≥4 days	36 (8.1)	37 (8.3)
Location of pain — no. (%)		
Right lower quadrant	229 (51.4)	237 (53.0)
Whole abdomen	49 (11.2)	49 (11.4)
Epigastric	48 (10.8)	49 (11.0)
Lower abdomen	37 (8.3)	27 (6.0)
Periumbilical	25 (5.6)	31 (6.9)
Right abdomen	14 (3.2)	16 (3.6)
Other	10 (2.3)	6 (1.3)
Not applicable‡	18 (4.1)	12 (2.7)

Table 1. (Continued.)

Characteristic	Low-Dose CT Group (N=444)	Standard-Dose CT Group (N=447)
Body temperature — °C		
Median	36.8	36.7
Interquartile range	36.4–37.2	36.5–37.1
Blood-test results		
White-cell count — $\times 10^3/\text{mm}^3$		
Median	10.7	10.8
Interquartile range	7.8–14.1	8.0–14.3
Segmented neutrophils — %		
Median	77.0	77.3
Interquartile range	65.8–85.2	65.5–83.9
C-reactive protein — mg/dl		
Median	0.5	0.7
Interquartile range	0.3–2.5	0.3–3.3
Type of CT scanner — no. (%)		
16-detector-row	177 (39.9)	191 (42.7)
64-detector-row	154 (34.7)	144 (32.2)
256-detector-row	113 (25.5)	112 (25.1)
Radiologist — no. (%)		
Expert	217 (48.9)	225 (50.3)
Nonexpert	227 (51.1)	222 (49.7)

Table 2. Clinical Outcomes.*

Outcome	Low-Dose CT Group	Standard-Dose CT Group	P Value†	Difference (95% CI)	Risk Ratio (95% CI)
percentage points					
Primary end point					
Negative appendectomy rate — no. of patients/total no. (%)	6/172 (3.5)	6/186 (3.2)		0.3 (–3.8 to 4.6)	1.08 (0.37 to 3.13)
Secondary end points					
Need for one or more additional imaging tests — no. of patients/total no. (%)	14/438 (3.2)	7/441 (1.6)	0.09	1.6 (–0.4 to 3.9)	2.01 (0.84 to 4.81)
Interval between CT and nonincidental appendectomy — hr‡			0.02		
Median	7.1	5.6			
Interquartile range	4.3 to 11.7	3.4 to 9.2			
Interval between CT and discharge without surgery — hr			0.63		
Median	2.5	2.4			
Interquartile range	1.5 to 4.2	1.4 to 4.4			
Appendiceal perforation rate — no. of patients/total no. (%)	44/166 (26.5)§	42/180 (23.3)¶	0.46	3.2 (–5.9 to 12.4)	1.14 (0.79 to 1.64)
Hospital stay associated with nonincidental appendectomy — days			0.54		
Median	3.4	3.2			
Interquartile range	2.7 to 4.1	2.5 to 4.1			

Table 3. Negative Appendectomies.*

Characteristic	Low-Dose CT Group	Standard-Dose CT Group
number/total number		
Total	6/172	6/186
Sex		
Female	5/90	2/83
Male	1/82	4/103
Body-mass index		
<18.5 (underweight)	0/20	1/19
18.5–24.9 (normal)	5/119	4/129
25.0–29.9 (overweight)	0/32	1/33
30.0–34.9 (class I obesity)	1/1	0/4
35.0–39.9 (class II obesity)	0/0	0/1
≥40.0 (class III obesity)	0/0	0/0
Type of CT scanner		
16-detector-row	3/58	2/73
64-detector-row	1/73	2/64
256-detector-row	2/41	2/49
Radiologist		
Expert	1/81	2/91
Nonexpert	5/91	4/95
Appendectomy approach		
Laparoscopic	6/109	4/115
Open	0/63	2/71

Table 4. Diagnostic Performance of CT and Diagnostic Confidence.^a

CT Result	Low-Dose CT Group (N = 433)	Standard-Dose CT Group (N = 440)	Difference (95% CI) [†]	P Value [‡]
Diagnosis of appendicitis				
AUC	0.970	0.975	-0.005 (-0.030 to 0.020)	0.69
Sensitivity — no. of patients/total no. (%)§	156/165 (94.5)	171/180 (95.0)	-0.5 (-5.6 to 4.5)	>0.99
Specificity — no. of patients/total no. (%)§	250/268 (93.3)	244/260 (93.8)	-0.6 (-4.9 to 3.8)	0.72
Likelihood of appendicitis — no. of patients/total no. (%)¶				
Diagnosis subsequently confirmed				0.03
Grade 1	2/165 (1.2)	4/180 (2.2)		
Grade 2	7/165 (4.2)	5/180 (2.8)		
Grade 3	13/165 (7.9)	11/180 (6.1)		
Grade 4	53/165 (32.1)	34/180 (18.9)		
Grade 5	90/165 (54.5)	126/180 (70.0)		
Diagnosis subsequently not confirmed				0.06
Grade 1	185/268 (69.0)	206/260 (79.2)		
Grade 2	65/268 (24.3)	38/260 (14.6)		
Grade 3	11/268 (4.1)	11/260 (4.2)		
Grade 4	3/268 (1.1)	3/260 (1.2)		
Grade 5	4/268 (1.5)	2/260 (0.8)		
Indeterminate interpretation, grade 3 — no. of patients/total no. (%)	24/433 (5.5)	22/440 (5.0)	0.5 (-2.5 to 3.6)	0.66
Diagnosis of appendiceal perforation				
Sensitivity — no. of patients/total no. (%)	16/44 (36.4)	23/42 (54.8)	-18.4 (-38.0 to 2.8)	0.09
Specificity — no. of patients/total no. (%)	110/121 (90.9)	121/138 (87.7)	3.2 (-4.6 to 11.0)	0.33

Discussion

- Low-dose CT group was noninferior to the standard-dose CT group with regard to negative appendectomy rates
- low-dose CT instead of standard-dose CT -- - benefit from reduce radiation risk
- low-dose CT group VS standard-dose CT group --- more likely to require additional imaging tests, longer interval between the CT examination and appendectomy

Study limitation

- Study setting may have been biased toward low-dose CT
- Study was not sufficiently powered to conclusively analyze the some potential effects.
- Few of the patients included in the study were obese

Conclusion

- use of lowdose CT as the first-line imaging test was noninferior to standard-dose CT with respect to the negative appendectomy rate among young adults with suspected appendicitis.