Radiology

ORIGINAL RESEARCH • THORACIC IMAGING

Chest CT Findings in Marijuana Smokers

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See also the editorial by Galvin and Franks in this issue.

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Background: Global consumption of marijuana is increasing, but there is a paucity of evidence concerning associated lung imaging findings.

Purpose: To use chest CT to investigate the effects of marijuana smoking in the lung.

Materials and Methods: This retrospective case-control study evaluated results of chest CT examinations (from October 2005 to July 2020) in marijuana smokers, nonsmoker control patients, and tobacco-only smokers. We compared rates of emphysema, airway changes, gynecomastia, and coronary artery calcification. Age- and sex-matched subgroups were created for comparison with tobacco-only smokers older than 50 years. Results were analyzed using χ^2 tests.

Results: A total of 56 marijuana smokers (34 male; mean age, 49 years ± 14 [SD]), 57 nonsmoker control patients (32 male; mean age, 49 years ± 14), and 33 tobacco-only smokers (18 male; mean age, 60 years ± 6) were evaluated. Higher rates of emphysema were seen among marijuana smokers (42 of 56 [75%]) than nonsmokers (three of 57 [5%]) ($P < .001$) but not tobacco-only smokers (22 of 33 [67%]) ($P = .40$). Rates of bronchial thickening, bronchiectasis, and mucoid impaction were higher among marijuana smokers compared with the other groups ($P < .001$ to $P = .04$). Gynecomastia was more common in marijuana smokers (13 of 34 [38%]) than in control patients (five of 32 [16%]) ($P = .039$) and tobacco-only smokers (two of 18 [11%]) ($P = .040$). In age-matched subgroup analysis of 30 marijuana smokers (23 male), 29 nonsmoker control patients (17 male), and 33 tobacco-only smokers (18 male), rates of bronchial thickening, bronchiectasis, and mucoid impaction were again higher in the marijuana smokers than in the tobacco-only smokers ($P < .001$ to $P = .006$). Emphysema rates were higher in age-matched marijuana smokers (28 of 30 [93%]) than in tobacco-only smokers (22 of 33 [67%]) ($P = .009$). There was no difference in rate of coronary artery calcification between age-matched marijuana smokers (21 of 30 [70%]) and tobacco-only smokers (28 of 33 [85%]) ($P = .16$).

Conclusion: Airway inflammation and emphysema were more common in marijuana smokers than in nonsmokers and tobacco-only smokers, although variable interobserver agreement and concomitant cigarette smoking among the marijuana-smoking cohort limits our ability to draw strong conclusions.

Marijuana is the most widely used illicit psychoactive substance in the world (1) and the second-most commonly smoked substance after tobacco (2). Its use has increased in Canada since the legalization of nonmedical marijuana in 2018. In 2020, 20% of the population in Canada aged at least 15 years reported having used marijuana in the previous 3 months compared with 14% of the population before marijuana legalization (3). In the United States, the percentage of all adults reporting marijuana use within the previous year rose from 6.7% in 2005 to 12.9% in 2015 (4).

Marijuana is consumed via multiple routes, including smoking, vaporizing, and eating, with inhaled methods being the most common (5). It may be smoked by itself or mixed with tobacco. It is usually smoked without a filter, and users inhale larger volumes with a longer breath hold compared with tobacco smokers (6). For measures of airflow obstruction, one marijuana joint can produce an effect similar to that of 2.5–5.0 tobacco cigarettes (7). Marijuana smoke contains known carcinogens and other chemicals associated with respiratory diseases (8).

Numerous studies have focused on the relationship of marijuana to pulmonary function tests, symptoms, and lung cancer. Two recent systematic reviews (2,9) determined that heavy marijuana use can lead to respiratory symptoms similar to those in tobacco smokers, including cough, sputum production, and wheeze. These are likely related to inflammation of the tracheobronchial mucosa (10) and mucus hypersecretion (11). One study posits that although marijuana causes bronchitis in current users, it does not lead to irreversible airway damage (6). The relationship of marijuana use to pulmonary function test results and lung cancer occurrence is described as equivocal, and both review studies comment on the possibility of the bronchodilatory effect of chronic marijuana smoking leading to a long-term increase in forced vital capacity, a trend also observed in a large population-based cohort study (12). Pulmonary function tests also indicate central airway inflammation in marijuana smokers (6).

To our knowledge, only two previous studies (7,13) have evaluated lung imaging findings in marijuana smokers and neither could establish a clear association between marijuana smoking and emphysema. Other studies investigating this relationship have been case reports and small case series, with little ability to draw clinically relevant conclusions. Other possible lung imaging findings associated with marijuana smoking, such as bronchiectasis, have not been studied.

Summary

In this case-control study of marijuana smokers, nonsmokers, and tobacco-only smokers, smoking marijuana was associated with paraseptal emphysema, bronchiectasis, bronchial wall thickening, and airway mucoid impaction.

Key Results

- In this retrospective case-control study analyzing chest CT findings in 56 marijuana smokers, 57 nonsmokers, and 33 tobacco-only smokers, marijuana smokers had higher rates of airway changes than did tobacco-only smokers or nonsmokers ($P < .001$ to $P = .04$).
- Emphysema was more common in marijuana smokers than in nonsmokers (75% vs 5%, $P < .001$) and in age- and sex-matched marijuana smokers than in tobacco-only smokers (93% vs 67%, $P = .009$); the paraseptal subtype of emphysema was predominant in marijuana smokers.

The purpose of this study was to use chest CT to investigate the effects of marijuana smoking on the lung. We sought to determine if there were identifiable sequelae on chest CT images, including emphysema and signs of airway inflammation.

Materials and Methods

Patients

This retrospective case-control study was performed with approval and waiver of informed consent from the local institutional review board. We included chest CT studies obtained prior to November 2020 at The Ottawa Hospital, a tertiary care center, and its affiliate hospitals. Patients were assigned to one of the following three groups: marijuana smokers, nonsmoker control patients, or tobacco-only smokers.

Marijuana smokers.—Cases were identified by searching for the terms *marijuana* and *cannabis* in The Ottawa Hospital picture archiving and communications system, and results were filtered to include only those in which chest CT was performed. Charts were reviewed to assess the frequency and duration of marijuana use, as well as for concomitant tobacco use. A total of 56 marijuana smokers were identified with chest CT performed between October 2005 and July 2020. Patient ages were sorted into 5-year age blocks (15–19 years, 20–24 years, 25–30 years, etc), and the number of men and women in each age category was determined. Marijuana consumption was quantified using the conversion of 0.32 g of marijuana per joint, as described by Ridgeway et al (14).

Nonsmoker control patients.—The pool of control patients was identified by searching for the phrase *sarcoma initial staging* in The Ottawa Hospital picture archiving and communications system. Initial staging chest CT of patients with newly diagnosed sarcoma and without history of smoking, lung disease, or chemotherapy was chosen. Patient charts were reviewed for use of marijuana or tobacco. In the case of marijuana smokers, the patient was excluded from the nonsmoker control group and added to the marijuana smoker group. New control patients were then selected. If the patient smoked only tobacco, he or she was not included in the nonsmoker control group. Fifty-seven control patients were identified with chest CT performed between April 2010 and October 2019. Control subjects were sorted into 5-year age blocks, and an appropriate age- and sex-matched subgroup was created.

Tobacco-only smokers.—The pool of tobacco-only smokers included patients with a chest CT examination performed as part of the high-risk lung cancer screening program (minimum age, 50 years; smoking history, >25 pack-years). Tobacco-only smokers were selected in a similar manner to those in the nonsmoker control group. Patient charts were reviewed for use of marijuana. If marijuana use was identified, the patient was excluded and added to the group of marijuana smokers, and a new patient was selected. Thirty-three tobacco-only smokers were identified with chest CT performed between April and June 2019.

Age- and sex-matched subgroups.—Because the tobacco smoker group included only patients aged at least 50 years, similarly aged patients in the marijuana smoker group and the nonsmoker control group were included in the subgroup analysis.

Image Analysis

Chest CT studies were obtained with different multidetector scanners with a section thickness of 2 mm or less. Intravenous iopamidol (Isovue; Bracco Imaging) was used in contrast-enhanced studies. The typical volumetric CT dose index and dose-length product for contrast-enhanced studies were 5.7 mGy and 238.5 mGy · cm, respectively. All images from chest CT studies were reviewed separately by two thoracic fellowship-trained radiologists (G.R., P.S.; 10 and 3 years of experience, respectively), who were blinded to clinical history (ie, marijuana and tobacco use) and other imaging findings. To assess interobserver variability, CT images from 30 patients (10 patients from each group) were reviewed initially. Final statistical analyses were performed on imaging findings obtained using consensus reads involving both radiologists on the entire study population of 146 patients. Lung findings assessed were *(a)* emphysema and *(b)* airway changes.

Emphysema.—The predominant pattern of emphysema (paraseptal or centrilobular) was recorded in accordance with Fleischner society descriptions (15).

Airway changes.—Bronchiectasis and bronchial wall thickening (Fig 3A) in accordance with descriptions by Ooi et al (16) and mucoid impaction presence or absence were recorded. The presence or absence of inflammatory small airway disease, in the form of centrilobular nodular opacities (15), also was recorded. Air trapping was not assessed because expiratory acquisitions were not available for all patients.

Non–lung-related findings.—Gynecomastia was recorded with a cutoff dimension of 22 mm of breast tissue (17). Coronary artery calcification was evaluated using the ordinal scoring method previously used by Shemesh et al (18), and a score of 0–12 was recorded for each patient.

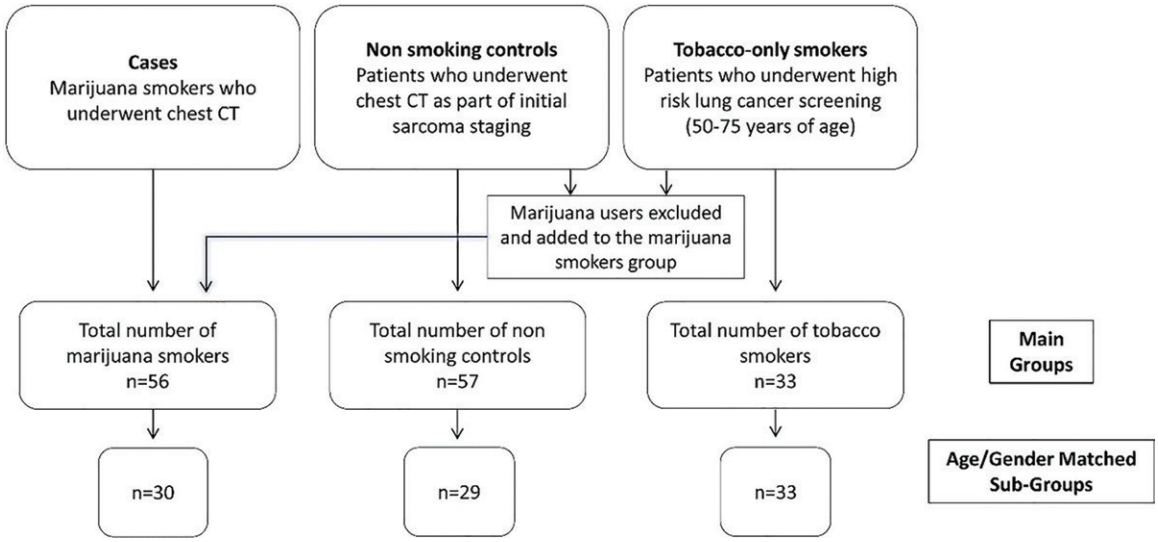

Figure 1: Flowchart shows patient inclusion and exclusion criteria for this study. Subgroups were created by age and sex matching to the tobacco-only cohort (who were taken from the high-risk lung cancer screening program; to qualify for screening, these patients needed to be 50 years or older). Any patients 50 years or older in the marijuana smoker or nonsmoker main groups were included in the subgroup analysis. Patients younger than 50 years in the marijuana smoker or nonsmoker main groups were excluded from subgroup analysis.

Table 1: Patient Characteristics

	Main Groups			Age- and Sex-matched Subgroups		
Characteristic	Marijuana Smokers (n = 56)	Nonsmoker Control Patients (n = 57)	Tobacco-only Smokers (n = 33)	Marijuana Smokers (n = 30)	Nonsmoker Control Patients (n = 29)	Tobacco-only Smokers (n = 33)
Age (y)*	49 ± 14 (20–73)	49 ± 14 (19–75)	60 ± 6 (50–71)	60 ± 6 (50–73)	61 ± 6 (51–75)	60 ± 6 (50–71)
Sex†						
Male	34	32	18	23	17	18
Female	22	25	15	7	12	15

* Data are mean ± SD, and data in parentheses are the range.

† Data are number of patients.

Statistical Analyses

Interobserver agreement was evaluated using the Cohen κ statistic. Results were analyzed using χ^2 tests to assess for significant differences in rates of emphysema, bronchiectasis, bronchial wall thickening, mucoid impaction, gynecomastia, and coronary artery disease between groups of marijuana smokers, tobacco smokers, and control patients; statistical significance was set at $P < .05$. Marijuana smokers were compared with control subjects in the main group analysis, and they were compared with both tobacco smokers and control patients in the subgroup analysis. The χ^2 tests were performed using an online statistics calculator *(https://www.socscistatistics.com/)*.

Results

Patient Characteristics

A total of 56 marijuana smokers (mean age, 49 years ± 14 [SD]; 34 male, 22 female) and 57 control patients (mean age, 49 years ± 14; 32 male, 25 female) were identified. Patients older than 50 years were included in subgroups for comparison with those who only smoked tobacco; subgroups consisted of 30 marijuana smokers (mean age, 60 years ± 6; 23 male, seven female), 29 control patients (mean age, 61 years ± 6; 17 male, 12 female), and 33 tobacco-only smokers (mean age, 60 years ± 6; 18 male, 15 female). Patient selection criteria are summarized in Figure 1, and patient characteristics are summarized in Table 1.

Our ability to quantify marijuana use was limited, with a daily amount specified in only 28 of 56 patients; average marijuana consumption among these patients was 1.85 g per day (range, 0.25–9.25 g per day). There were 50 of 56 marijuana-smokers who also smoked tobacco, with pack-year data specified in only 47 patients; average smoking history was 25 pack-years (range, 0–100 pack-years) (14).

For tobacco-only smokers, average smoking history was 40 pack-years (range, 25–105 pack-years).

Interobserver Agreement

For the analysis of 30 patients, interobserver agreement between the two readers was fair for assessment of bron-

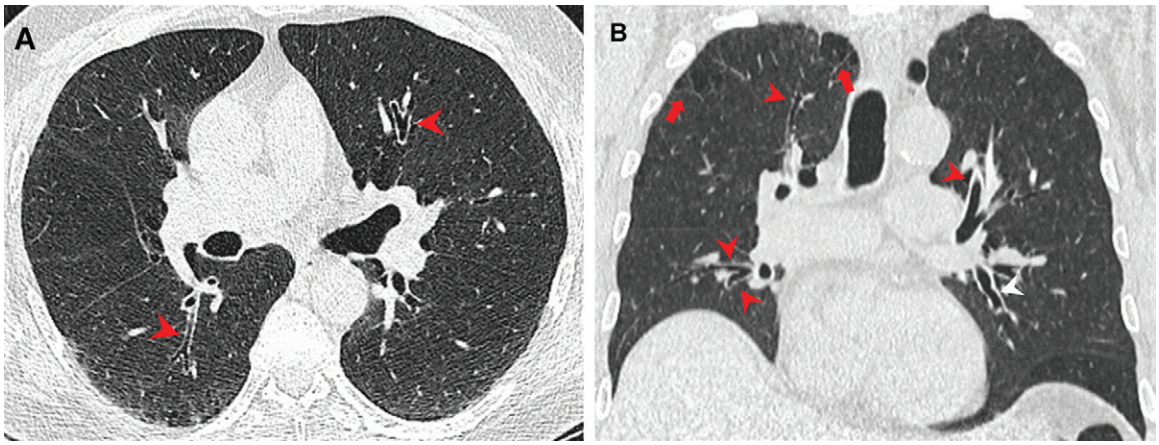

Figure 2: Airway changes in a 66-year-old male marijuana and tobacco smoker. Contrast-enhanced **(A)** axial and **(B)** coronal CT images show cylindrical bronchiectasis and bronchial wall thickening (arrowheads) in multiple lung lobes bilaterally in a background of paraseptal (arrows) and centrilobular emphysema.

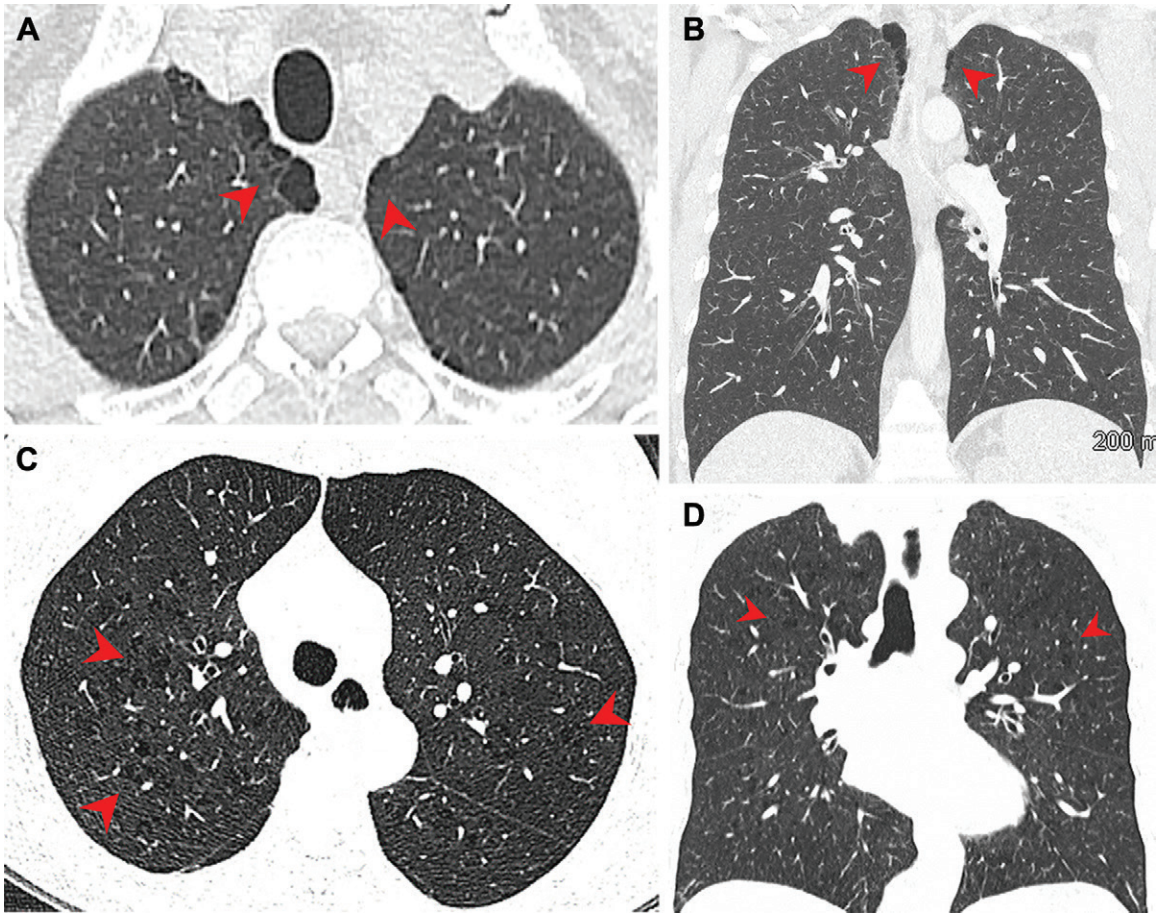

Figure 3: Pulmonary emphysema in **(A, B)** marijuana and **(C, D)** tobacco smokers. **(A)** Axial and **(B)** coronal CT images in a 44-year-old male marijuana smoker show paraseptal emphysema (arrowheads) in bilateral upper lobes. **(C)** Axial and **(D)** coronal CT images in a 66-year-old female tobacco smoker with centrilobular emphysema represented by areas of centrilobular lucency (arrowheads).

chiectasis (κ = 0.27), moderate for assessment of bronchial wall thickening (κ = 0.49), substantial for assessment of emphysema (κ = 0.79), and strong for assessment of mucoid impaction (κ = 0.84).

Marijuana Smokers versus Nonsmoker Controls

There were differences in rates of emphysema (both paraseptal and centrilobular) (75% vs 5%, $P < .001$), bronchial thickening (64% vs 11%, $P < .001$), bronchiectasis (23% vs 4%, $P = .002$),

Table 2: Rates of Thoracic CT Findings among Marijuana Smokers, Nonsmoker Control Patients, and Tobacco Smokers (Main Groups)

Finding	Marijuana Smokers	Nonsmoker Control Patients	Tobacco-only Smokers	*P* Value for Marijuana Smokers vs Nonsmoker Control Patients	*P* Value for Marijuana Smokers vs Tobacco-only Smokers
Emphysema	42/56 (75) [63, 87]	3/57 (5) [0, 11]	22/33 (67) [50, 83]	<.001	.40
Paraseptal emphysema	27/56 (48) [35, 61]	3/57 (5) [0, 11]	8/33 (24) [9, 39]	<.001	.03
Bronchial thickening	36/56 (64) [51, 77]	6/57 (11) [2, 19]	14/33 (42) [25, 60]	<.001	.04
Bronchiectasis	13/56 (23) [12, 34]	2/57 (4) [0, 8]	2/33 (6) [0, 14]	.002	.04
Mucoid impaction	26/56 (46) [33, 60]	1/57 (2) [0, 5]	5/33 (15) [3, 28]	<.001	.003
Gynecomastia	13/34 (38) [22, 55]	5/32 (16) [3, 28]	2/18 (11) [0, 26]	.04	.04
Coronary artery calcification	24/56 (43) [30, 56]	15/57 (26) [30, 112]	28/33 (85) [72, 97]	.06	<.001

Note.—Data are numbers of patients (numerator and denominator). Data in parentheses are percentages, and data in brackets are 95% CIs.

Table 3: Rates of Thoracic CT Findings among Marijuana Smokers, Nonsmoker Control Patients, and Tobacco Smokers (Age- and Sex-matched Subgroups)

Finding	Marijuana Smokers	Nonsmoker Control Patients	Tobacco-only Smokers	*P* Value for Marijuana Smokers vs Nonsmoker Control Patients	*P* Value for Marijuana Smokers vs Tobacco-only Smokers
Emphysema	28/30 (93) [84, 100]	2/29 (7) [0, 16]	22/33 (67) [50, 83]	<.001	.009
Paraseptal emphysema	17/30 (57) [39, 75]	2/29 (7) [0, 16]	8/33 (24) [9, 39]	<.001	.009
Bronchial thickening	25/30 (83) [70, 97]	6/29 (21) [6, 36]	14/33 (42) [25, 60]	<.001	<.001
Bronchiectasis	10/30 (33) [16, 50]	2/29 (7) [0, 16]	2/33 (6) [0, 14]	.01	.006
Mucoid impaction	20/30 (67) [50, 84]	1/29 (3) [0, 10]	5/33 (15) [3, 28]	<.001	<.001
Gynecomastia	10/23 (43) [23, 64]	3/17 (18) [0, 36]	2/18 (11) [0, 26]	.08	.02
Coronary artery calcification	21/30 (70) [50, 84]	14/29 (48) [30, 67]	28/33 (85) [72, 97]	.09	.16

Note.—Data are numbers of patients (numerator and denominator). Data in parentheses are percentages, and data in brackets are 95% CIs.

and mucoid impaction (46% vs 2%, $P < .001$) between marijuana smokers and nonsmoker control patients, respectively. No patient had pneumothorax.

Subgroup analysis demonstrated differences in frequency of bronchial thickening (83% vs 21%, $P < .001$), bronchiectasis (33% vs 7%, $P = .012$) and mucoid impaction (67% vs 3%, $P < .001$) between marijuana smokers and nonsmoker control patients, respectively.

Centrilobular nodules were observed in 18% of marijuana smokers while no nonsmoker control patients exhibited this finding ($P < .001$). Gynecomastia was significantly more common in marijuana smokers than in nonsmoker control patients (38% vs 16%, $P = .04$). While there was a difference in coronary artery calcification rates between marijuana smokers and nonsmoker control patients (43% vs 26%,), this did not reach statistical significance ($P = .06$).

Marijuana Smokers versus Tobacco-only Smokers

Differences in bronchial thickening (64% vs 42%, $P = .04$), bronchiectasis (23% vs 6%, $P = .04$), and mucoid impaction (46% vs 15%, $P = .003$) were seen in the non–age-matched marijuana group compared with the tobacco-only group. Subgroup analysis again demonstrated significant differences in rates of bronchial thickening (83% vs 42%, $P < .001$), bronchiectasis (33% vs 6%, $P = .006$), and mucoid impaction (67% vs 15%, $P < .001$) in marijuana smokers compared with tobacco-only smokers. Figure 2 demonstrates CT findings of airway changes in a combined marijuana and tobacco smoker. Variable interobserver agreement limits our ability to draw strong conclusions about bronchial wall thickening and bronchiectasis.

We found no difference between the overall rates of emphysema (including both paraseptal and centrilobular emphysema) when comparing non–age-matched marijuana smokers and tobacco-only smokers (75% vs 67%, $P = .40$); however, higher rates of emphysema were noted when the age-matched marijuana group was compared with the tobacco-only group (93% vs 67%, $P = .01$). Also, a significant difference in a paraseptal predominant pattern of emphysema was seen in the marijuana smokers compared with the tobacco-only smokers (57% vs 24%, $P = .009$) (Fig 3), while we found no evidence of a difference in the proportion of those with a centrilobular pattern (37% vs 39%, $P = .82$). Rates of the key CT findings in each cohort are summarized for the main group in Table 2 and for the subgroup in Table 3.

Discussion

In this era of legalization and increasing consumption of marijuana, we sought to identify the imaging features of marijuana smoking on chest CT scans. We found higher rates of emphysema among marijuana smokers (42 of 56, 75%) than among nonsmokers (three of 57, 5%) ($P < .001$) and among age-matched marijuana smokers (28 of 30, 93%) than among tobacco-only smokers (22 of 33, 67%) ($P = .009$). Paraseptal emphysema was more predominant in marijuana smokers (27 of 56, 48%) than in tobacco-only smokers (eight of 33, 24%) ($P = .03$) and in age-matched marijuana smokers (17 of 30, 57%) than in tobacco-only smokers (eight of 33, 24%) ($P = .009$). Markers of airway inflammation were higher among marijuana smokers than among other groups for both non–age-matched and age-matched subgroup comparisons ($P < .001$ to $P = .04$). Gynecomastia was more common in marijuana smokers (13 of 34, 38%) than in control patients (five of 32, 16%) ($P = .039$) or tobacco-only smokers (two of 18, 11%) ($P = .04$). There was no evident difference in the presence of coronary artery calcification between age-matched marijuana smokers (21 of 30, 70%) and tobacco-only smokers (28 of 33, 85%) ($P = .16$).

It has been posited that certain maneuvers performed by marijuana smokers, such as full inhalation with a sustained Valsalva maneuver, may lead to microbarotrauma and peripheral airspace changes, such as apical bullae. In our study, paraseptal emphysema was the predominant pattern seen in marijuana smokers, while centrilobular emphysema was the predominant pattern seen in tobacco-only smokers. This may represent an earlier stage of apical bulla formation reported in marijuana smokers (19,20) and may explain the absence of the typical pulmonary function test changes of chronic obstructive pulmonary disease in marijuana smokers. The χ^2 tests revealed similar overall rates of emphysema in the non–age-matched marijuana smoker group and the tobacco-only smoker groups and higher rates of emphysema among age-matched marijuana smokers compared with tobacco-only smokers. This is in contradistinction to a study by Ruppert et al (21), which showed similar prevalence of emphysema among 38 tobacco-only smokers and 32 tobacco and marijuana smokers but occurrence of emphysema in the latter group at a younger age. We were not able to establish a definite association between marijuana smoking and emphysema or bullous disease. Causality needs to be further examined in larger patient cohorts with prospective accurate quantification data, given the increasing body of evidence suggesting an association between smoking marijuana and spontaneous pneumothorax (22,23).

Bronchiectasis, bronchial wall thickening, and mucoid impaction are CT indicators of airway inflammation. Our findings suggest that smoking marijuana leads to chronic bronchitis in addition to the airway changes associated with smoking tobacco. This is especially striking given the extensive smoking history of patients in the tobacco-only group (smoking history, 25–100 pack-years). In addition, our results were still significant when comparing the non–age-matched groups, including younger patients who smoked marijuana and who presumably had less lifetime exposure to cigarette smoke. Further studies in larger cohorts are needed to better define imaging correlates of airway inflammation and chronic bronchitis that have been described in association with marijuana smoking in previous clinical studies and systematic literature reviews (2,24).

Poorly defined centrilobular ground-glass nodules can denote inflammatory small airway disease corresponding to the entity of respiratory bronchiolitis characterized by accumulation of pigmented histiocytes adjacent to respiratory bronchioles and alveolar ducts and sacs. This finding is commonly related to cigarette smoking (25,26) but can be related to inhalation of a variety of toxic particles (15). A histopathologic study comparing 10 marijuana smokers with five tobacco smokers and five nonsmokers reported that marijuana smoking was associated with massive intra-alveolar accumulation of pigmented histiocytes evenly throughout the pulmonary parenchyma, assumed to be related to higher particulate matter concentration and deeper and longer inhalation techniques used by marijuana smokers (27). In our study, we found no differences in the occurrence of centrilobular nodules between marijuana smokers and tobacco-only smokers. However, this may be because 89% (50 of 56) marijuana smokers were also tobacco smokers. Further assessment in imaging-based studies with larger patient cohorts and better quantification data are required. Furthermore, biopsy confirmation may be needed to better understand the histopathology of these nodules in marijuana smokers: Are they related to respiratory bronchiolitis or organizing pneumonia (described by Berkowitz et al [28]).

We were unable to confirm an association between coronary artery calcification and marijuana smoking, similar to a systematic review of 24 articles that reported that evidence on the association of marijuana use with cardiovascular risk factors is insufficient to make conclusions (29). At least one recent study of 146 young marijuana users with chest pain found that marijuana use did not confer additional risk of coronary artery disease, as detected with coronary CT angiography (30). Tobacco smoking, on the other hand, is an established risk factor for coronary artery disease (31). Our study also enabled us to confirm the well-known relationship between regular long-term marijuana use and gynecomastia (32).

Our study had limitations. First, the small sample size precluded us from drawing strong conclusions. Second, the retrospective nature of the study had its own inherent limitations. Third, there was inconsistent quantification of patient marijuana use, due in part to the previous illegal nature of marijuana possession, which led to a lack of patient reporting. Accurate quantification is further complicated by the fact that users often share joints, use different inhalation techniques, and use marijuana of varying potency. Fourth, given that most marijuana smokers also smoke tobacco, the synergistic effects of these two substances cannot be effectively evaluated. Fifth, only a portion of patients could be age matched, since the tobacco-only cohort was taken from the lung cancer screening study and the patients were aged at least 50 years. Due to the age mismatch in the larger cohort, there are differences in the duration of smoking. Lastly, variable interobserver agreement

limits our ability to draw strong conclusions about bronchial wall thickening and bronchiectasis.

In conclusion, our study suggests that distinct radiologic findings in the lung may be seen in marijuana smokers, including higher rates of paraseptal emphysema and airway inflammatory changes, such as bronchiectasis, bronchial wall thickening, and mucoid impaction when compared with nonsmoker control patients and those who only smoke tobacco. These findings may be related to specific inhalational techniques while smoking marijuana, as well as to the bronchodilatory and immunomodulatory properties of its components. Further larger and prospective studies are necessary to confirm and further elucidate these findings, as marijuana use is bound to increase in the future, given the increasing legalization of its use for medical and recreational purposes.

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Disclosures of conflicts of interest: **L.M.** No relevant relationships. **P.S.** No relevant relationships. **J.P.S.** No relevant relationships. **M.D.F.M.** *Radiology* editorial board. **G.R.** Legal advice for BLG firm.

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