

## CASE REPORT

# Marijuana Lung: Radiological, macroscopic and histopathological triptych

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## ABSTRACT

“Marijuana lung” refers to a radiological-pathological entity of apical (bullous) paraseptal emphysema in persons who regularly smoke cannabis. We describe a post-mortem case of a drowned young man in whom apical bullous emphysema was seen on post-mortem computed tomography (PMCT) as an incidental finding. Histopathology confirmed the existence of apical paraseptal emphysema. Toxicology, including hair analysis, confirmed that he was a chronic cannabis user. As such this case report can be supportive of the association between chronic cannabis use and the development of paraseptal emphysema.

**Keywords:** Cannabis, Post-mortem Imaging, Marijuana Lung, Paraseptal Emphysema

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## INTRODUCTION

In the western world cannabis is the most widely used illicit drug.<sup>1</sup> It is estimated that 1% of all European adults use cannabis on a daily basis. In Belgium, growing or possessing cannabis remains a crime punishable by a fine or prison sentence. Nevertheless, for the reason of decriminalization, cannabis use is given a 'low prosecution priority'.

Marijuana is the most common form of cannabis. “Marijuana lung” refers to a radiological-pathological entity where there is apical bullous paraseptal

emphysema in persons who regularly smoke cannabis.<sup>2</sup> Paraseptal emphysema indicates emphysema bounded by any pleural surface and/or interlobular septa.<sup>3</sup> The current modality of choice for detecting emphysema is computed tomography (CT), with high-resolution CT (HRCT) being particularly effective.

Current literature regarding cannabis use and lung emphysema is mainly based on a radiological and/or clinical perspective. Since this is a forensic case, we had the advantage of also performing toxicological hair analysis to objectify chronic cannabis use. Therefore we could overcome problems associated with self-reporting of illegal substances use.<sup>4</sup>

## Case

A body was noticed in a dock in the port of Antwerp. Police identified the person as a 30-year-old Caucasian man and the body was transferred to the forensic department of the University Hospital of Antwerp. This person was known by the police for drug (cannabis) and alcohol misuse previously. Imaging, full autopsy, microscopic examination and toxicological analysis were performed. Urine was positive for tetrahydrocannabinol (THC).

## Imaging

Total body CT was performed prior to autopsy. Scan was obtained on a 160 mm detector CT (GE Revolution CT, General Electric, Milwaukee, WI, USA). CT-findings associated with drowning<sup>5</sup> were reported: fluid in the paranasal sinuses, fluid in some mastoid air cells, fluid in the lower airways and ground-glass opacity of the lung parenchyma. Further, paraseptal emphysema limited to the upper lungs was detected (Figure 1A), which is unusual considering the victim's age. The findings suggested the use of cannabis and/or heavy smoking.

In this age group, paraseptal emphysema with risk of spontaneous pneumothorax typically occurs in tall, lean men, especially smokers.<sup>6</sup> Regardless of age, paraseptal emphysema is often seen in patients with chronic obstructive pulmonary diseases (COPD) (and thus often heavy smokers).

## Autopsy

This was an adult male with an athletic physique. He had a small laceration on the forehead and there

were some bruises on the legs, possibly sustained while in the water. There were no other abnormalities.

On opening the chest, hyperinflated lungs ("kissing lungs") were seen. The chest cavity contained a significant amount of serous pleural fluid. There was pulmonary anthracosis. The left lung weighed 777 g and the right lung 972 g. Both lungs were edematous and congested. The trachea and tracheal bronchi contained white, bubbling froth. The pulmonary vessels were unremarkable. Both lungs showed apical paraseptal emphysema (Figure 1B).

## Histology

Apical lung tissue showed paraseptal emphysema. Airspace enlargement with fragmentation of the alveolar walls were seen (Fig. 1C and 1D). The remaining lung fragments, revealed preserved lung tissue with moderate edema, strong interstitial congestion and alveolar wall disruption – *emphysema aquosum*. Histological examination of the other organs were unremarkable.

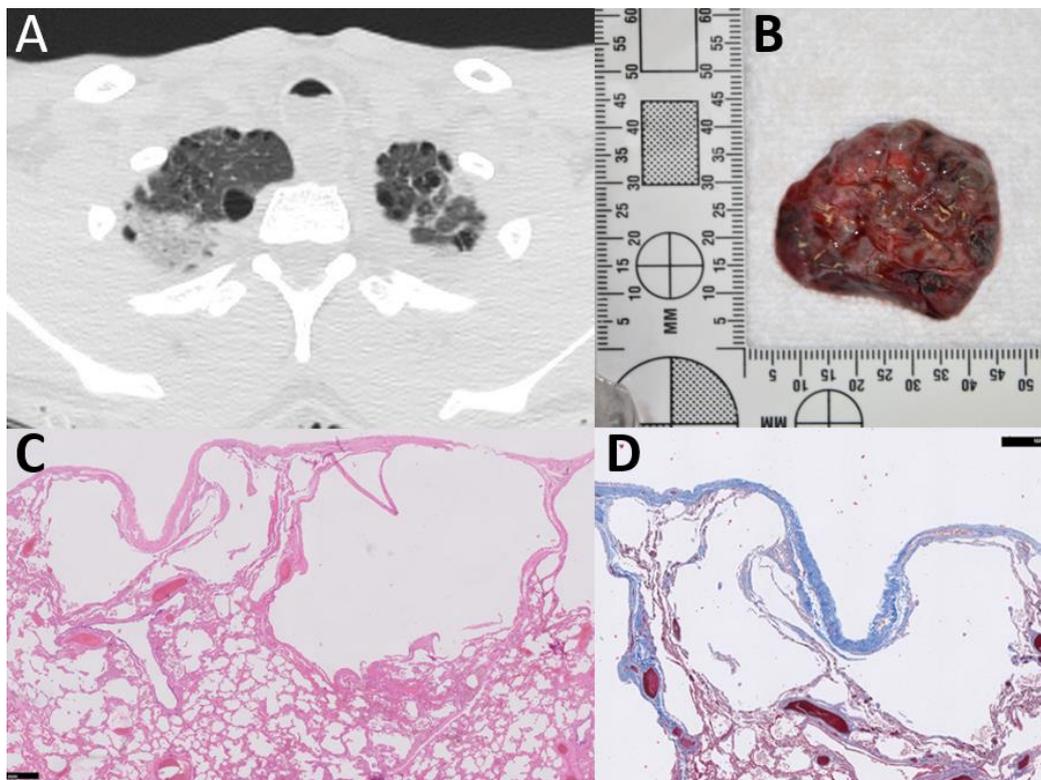


Fig. 1: A Post-mortem CT image of the chest in lung window, demonstrating apical lung emphysema (axial view).  
 B Apical lung tissue with visible emphysema (axial slice).  
 C Low magnification photomicrograph of the lung section showing paraseptal emphysema, scale bars 1 mm. (Hematoxylin-eosin stain)  
 D Low magnification photomicrograph of the lung section showing paraseptal emphysema, scale bars 1 mm. (Trichrome-Masson stain).

## Toxicology

Ethanol concentration in blood, urine, and vitreous fluid was respectively 2.8 g/L, 1.3 g/L and 3.2 g/L. Gas chromatography tandem mass spectrometry (GC-MS/MS) revealed 126 ng/mL 11-nor-9-carboxy-delta-9-tetrahydrocannabinol (THC-COOH, the main metabolite of THC) in urine. Post-mortem blood analysis revealed following concentrations: 15.6 ng/mL THC, 7.2 ng/mL 11-hydroxy-THC (11-OH-THC, the active metabolite of THC) and 42 ng/mL THC-COOH. 11-OH-THC and THC-COOH were also found in the liver and kidney. THC-COOH tracing in the 3 cm hair segment was conducted via the procedure published by Van Elsué et al.<sup>7</sup> and revealed a concentration of 18.1 pg/mg. For this value, a 0.20 pg/mg cut-off is maintained by the Society of Hair Testing (SOHT) and a 0.05 pg/mg by the Substance Abuse and Mental Health Services Administration (SAMHSA).

The detection of THC and its active metabolite 11-OH-THC in blood indicates cannabis use in the last hours before death. The high level of THC-COOH indicates regular use. And the detection of THC-COOH in the hair segment indicates regular use in the three months before death. The combined effect of the high quantities of alcohol and THC in blood undoubtedly severely reduced the reactions and alertness of this man, which could have contributed to the fatal outcome.

Autopsy findings and additional technical investigations attributed this death to drowning.

## DISCUSSION

The *Cannabis* plant produces cannabinoids that can induce an altered psychoactive state ("high"). THC is the primary psychoactive cannabinoid. Marijuana specifically refers to the leaves, flower parts and viable seeds of the plant and is the most common form of cannabis. Marijuana can be smoked in hand-rolled cigarettes (joints) or in a pipe (bong).

The correlation between smoking cannabis and paraseptal emphysema, specifically in younger patients, has been reported.<sup>2,8,9,10</sup> The exact mechanism for development of emphysema is not well known; a definite causative link has not yet been established. Direct pulmonary toxicity from the components in cannabis itself in combination with airway barotrauma related to the inhalation technique (high inspiratory pressure with prolonged breath-hold) may play a role.<sup>2</sup> The predominant apical involvement may thus be explained by deep inspiratory manoeuvres commonly performed when

smoking marijuana.<sup>2,11</sup> The majority of patients, however, are asymptomatic and may only occasionally present with spontaneous pneumothorax (secondary to bullous rupture). Therefore emphysema will mostly be an incidental finding on imaging<sup>12</sup> or during autopsy.

On CT, emphysematous regions are seen as low attenuation areas. There is, however, a relatively poor correlation between autopsy-proven emphysema and CT. Around 20% of pathology-proven cases are not evident on CT.<sup>13</sup> It is recommended to include cannabis (ab)use in the differential diagnosis in all cases of bullous lung emphysema in young individuals.<sup>12</sup>

On the other hand, a recent study from De Bakker et al.<sup>14</sup> re-evaluated 290 PMCT's from deceased aged between 21 and 70 years and found a surprisingly high incidence of small bullae and/or blebs in one third of the cases. However, these authors did not have data on drug use of the deceased.

General microscopic findings of emphysema are airspace enlargement and fragmentation of the alveolar walls. Fiorelli A et al.<sup>9</sup> showed that marijuana users had a higher incidence of inflammatory cells in their lungs, which may favor lung injury and bullae formation. Also, mild fibrotic changes can be seen.<sup>15</sup>

One of the difficulties in proving this causal relationship is that many cannabis users also smoke tobacco, which can also be a cause for paraseptal emphysema in young patients.<sup>2</sup> However, smoking tobacco for a longer period of time is typically associated with more uniformly distributed centrilobular emphysema<sup>10</sup> and the macroscopic emphysema seen at autopsy was neither uniformly distributed, nor centrilobular. The pulmonary anthracosis seen at the autopsy nonetheless, could be an indicator of concomitant cigarette smoking.

As stated above, a definite causative link between smoking cannabis and bullous lung emphysema has not yet been established. Cannabis use is still illegal in most countries. This makes it difficult to collect data from individual users. However, toxicology in our case indicates regular cannabis use and can as such be supportive of the association between cannabis use and paraseptal emphysema.

**ETHICAL ISSUES**

None

**CONFLICTS OF INTEREST**

The authors do not have any conflicts of interest in developing and publishing this manuscript.

**AUTHOR CONTRIBUTIONS**

Van Hoyweghen Astrid: Interpreted the post-mortem imaging and Revised the article;

Jacobs Werner: Performed the autopsy and Revised the article;

Neels Hugo: Carried out the toxicological analysis and Revised the article;

Van Goethem Alexia: Reviewed the literature and Drafted the work.

**REFERENCES**

1. Lange P. Cannabis and the lung. *Thorax*. 2007;62(12):1036–7. doi:10.1136/thx.2007.084830
2. Leb JS, D'Souza B, Steiner RM. Marijuana lung. *Chronic Obstructive Pulmonary Diseases*. 2018;5(1):81–3. doi:10.15326/jcopdf.5.1.2017.0180
3. Araki T, Nishino M, Zazueta OE, Gao W, Dupuis J, Okajima Y, et al. Paraseptal emphysema: Prevalence and distribution on CT and association with interstitial lung abnormalities. *European Journal of Radiology*. 2015;84(7):1413–8. doi:10.1016/j.ejrad.2015.03.010
4. Ribeiro LIG, Ind PW. Effect of cannabis smoking on lung function and respiratory symptoms: A structured literature review. *npj Primary Care Respiratory Medicine*. 2016;26(August). doi:10.1038/npjpcrm.2016.71
5. Van Hoyweghen AJL, Jacobs W, Op de Beeck B, Parizel PM. Can post-mortem CT reliably distinguish between drowning and non-drowning asphyxiation? *International Journal of Legal Medicine*. 2014;129(1):159–64. doi:10.1007/s00414-014-1037-6
6. Cheng YL, Huang TW, Lin CK, Lee SC, Tzao C, Chen JC, et al. The impact of smoking in primary spontaneous pneumothorax. *Journal of Thoracic and Cardiovascular Surgery* [Internet]. 2009;138(1):192–5. doi:10.1016/j.jtcvs.2008.12.019
7. Van Elsué N, Yegles M. Influence of cosmetic hair treatments on cannabinoids in hair: Bleaching, perming and permanent coloring. *Forensic Science International*. 2019;297:270–6. doi:10.1016/j.forsciint.2019.02.030
8. Beshay M, Kaiser H, Niedhart D, Reymond MA, Schmid RA. Emphysema and secondary pneumothorax in young adults smoking cannabis. *European Journal of Cardio-thoracic Surgery*. 2007;32(6):834–8. doi:10.1016/j.ejcts.2007.07.039
9. Fiorelli A, Accardo M, Vicidomini G, Messina G, Laperuta P, Santini M. Does cannabis smoking predispose to lung bulla formation? *Asian Cardiovascular and Thoracic Annals*. 2014;22(1):65–71. doi:10.1177/0218492313478954
10. Johnson MK, Smith RP, Morrison D, Laszlo G, White RJ. Large lung bullae in marijuana smokers. *Thorax*. 2000;55(4):340–2. doi:10.1136/thorax.55.4.340
11. Tashkin DP, Coulson AH, Clark VA. Respiratory symptoms and lung function in habitual heavy smokers of marijuana alone, smokers of marijuana and tobacco, smokers of tobacco alone and nonsmokers. *American Review of Respiratory Disease*. 1986;135(1).
12. Golwala H. Marijuana abuse and bullous emphysema. *Lung India*. 2012;29(1):56–8. doi:10.4103/0970-2113.92365
13. Stern EJ, Frank MS. CT of the lung in patients with pulmonary emphysema: Diagnosis, quantification, and correlation with pathologic and physiologic findings. *American Journal of Roentgenology*. 1994;162(4):791–8. doi:10.2214/ajr.162.4.8140992
14. de Bakker H, Tijstermans M, de Bakker O, Soerdjbalie-Maikoe V, van Hulst R, de Bakker B. Prevalentie van bullae en blebs bij post-mortem CT. 2019;7–10.
15. Yoshikawa A, Bychkov A. Emphysema.