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Detecting illegal intra-corporeal cocaine containers: Which factors influence their density?

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ABSTRACT

Purpose: To determine parameters related to hyperdensity (> 40 HU) of intra-corporeal cocaine packets on low-dose CT (LDCT); hyperdensity increases detectability on abdominal radiographs.
Methods: LDCT showing drug packets (n = 46) were analyzed for mean radiological density and packets volume. Following expulsion, packets weight and cocaine concentration were measured. Hypercompaction was defined as > 0.9 g/cm^3.
Results: Packets were hyperdense in 33 cases (72%). Mean compaction was 1.0 g/cm^3, mean density 118.5 HU and mean cocaine concentration 44.2%. On multivariate analysis, only high compaction remained significantly related to hyperdensity (p = 0.001).
Conclusion: Compaction > 0.9 g/cm^3 is the only parameter significantly associated with hyperdense packets.

1. Introduction

Detecting drugs thought to be carried within the body of suspected body packers is a complex procedure, involving several profiling-type investigations (administrative tests, saliva and urine analyses, and testing for cocaine on the hands) [1,2]. A suspect is typically referred to a medical center to undergo an abdominal X-ray, aimed to confirm the presence or absence of illegal intra-corporeal containers (packets) of cocaine [3–5].

The abdominal plain film (APF) is the most commonly-used method in medical centers for screening individuals suspected of having ingested drug packets. Recent studies have demonstrated this technique's limitations, however, compared to computed tomography (CT) using low radiation doses [6–8]. Low-dose CT (LDCT) is a CT imaging technique with no contrast injection, that delivers six times lower radiation doses than standard CT, which is equivalent to the doses used in APF [9–12]. Nearly a quarter of all drug packets revealed by LDCT are undetectable using APF [6]. A comparative analysis between APF and LDCT demonstrated that packets that exhibit low density (hypodensity) on LDCT compared to the intestinal content are more difficult to detect using APF than those that are more dense (hyperdense) [6]. The reason why some cocaine packets appear denser than others on LDCT is as yet unknown, and is a significant question given the relationship established between the density of intra-corporeal packets on LDCT and their detectability on standard radiography.

The aim of our study was to determine the parameters that could influence the density of intra-corporeal illegal cocaine packets on LDCT.

2. Materials and methods

All individuals suspected of carrying illegal intestinal packets within our state borders were brought to our hospital to undergo abdominal LDCT screening. When positive for drug packets (n = 85), body packers were hospitalized until all packets were expelled and retrieved. The packets were then handed to the police, and a specialized analysis was performed by a dedicated scientific police laboratory. This retrospective study received the approval of our institution's research ethics committee (CER 13-027-R).

2.1. Chemical analysis

For each positive case, the scientific laboratory analyzed the weight

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(g) of the packets and their cocaine concentration (%), and performed a qualitative analysis of the cutting agents. These data were retained by the scientific police up to the end of the study.

2.2. Exclusion criteria

Cases were excluded from analysis when measures showed a difference between packets of 20% or more with regard to cocaine concentration, packet weight, and size or radiological densities (lowest and highest value) in a same body-packer. A difference in the measured density of 20% or more within a same packet was also a criterion for exclusion.

We also excluded cases for which laboratory data could not be obtained.

2.3. Technical parameters

LDCT was performed with a 64-row GE 750 HD CT (Discovery 750 HD CT, GE Healthcare, Milwaukee, USA), from lung base to pelvis, without intravenous, oral, or rectal contrast material, using the following parameters: 64 × 1.25 mm collimation, 1.375 pitch, 0.7 s gantry rotation period, 120 kV tube potential, 25.2 mAs tube charge per gantry rotation, and 2.5 mm reconstruction slice thickness, using a 40% adaptive statistical iterative reconstruction (ASIR) algorithm.

2.4. Effective LDCT dose

The dose of radiation delivered by LDCT was estimated from the mean normalized value of effective dose-length product (DLP) for the abdomen [13]. The effective dose for LDCT was 1.4 mSv (DLP = 94.15[mGy.cm]) for men and 1.2 mSv for women (DLP = 83.54[mGy.cm]).

2.5. Image analysis

LDCT images were immediately interpreted by the radiology fellow of our emergency radiology unit, who issued a written report indicating the presence or absence of intra-corporeal packets.

Following this, all images positive for packet presence on abdominal LDCT were transferred to a dedicated workstation (OsiriX v4.0 64 bit, Pixmeo) and analyzed by a board-certified radiologist from the emergency radiology unit, who was blinded to the results of the chemical analysis. Firstly, the radiologist did assess whether packets were visible or not on the scout images on a binary scale. For each body-packer, the mean radiological density in Hounsfield units (HU) was measured in a packet, using a 60 mm^2 circular region of interest (ROI). The ROI was placed in a visually homogenous part of a packet, free of artifacts.

Packets presenting density higher than 40 HU were considered hyperdense (Fig. 1), those presenting density lower or equal to 40 HU were considered isodense (Fig. 2) as compared to bowel content; the threshold of 40 HU corresponds to the mean density of the intestinal content.

The same packets were then analyzed in terms of volume, using multiplanar reconstruction techniques. Considering each packet as a cylinder, the volume (cm^3) was calculated by multiplying the area, measured in its axial plane, by the length (Fig. 3).

Once the packet weight had been transmitted by the police laboratory, the bulk density (compaction), expressed in g/cm^3, was calculated by dividing the weight of the packet by its volume calculated based on LDCT.

2.6. Statistical analysis

Analyses were performed using SPSS Version 22 (IBM® SPSS® Statistics V22.0), with Fischer's exact test used to analyze categorical variables, and Student's *t*-test for continuous variables.

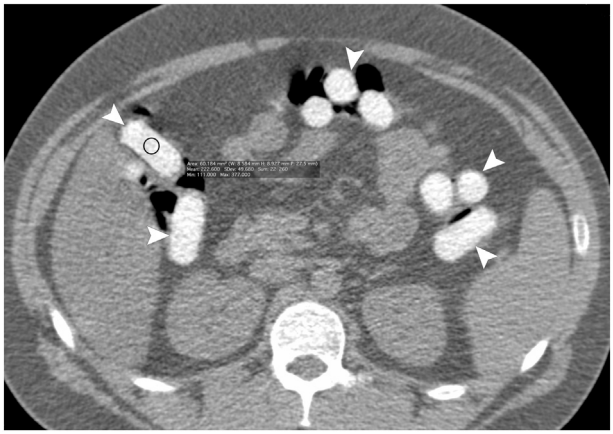

Fig. 1. Twenty-nine-years old man, positive for conveying cocaine packets
Axial abdominal LDCT shows multiple hyperdense packets within the small and large bowel (arrowheads), with a mean density of 223 HU.
Laboratory analyses revealed a concentration of cocaine of 68.5%; the calculated compaction was 1.2 g/cm^3.

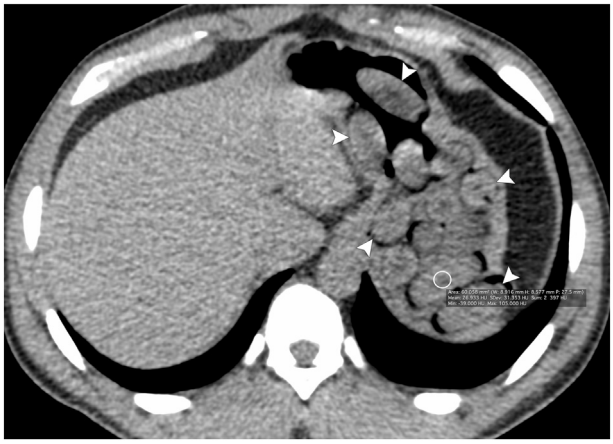

Fig. 2. Thirty-years-old man, positive for conveying cocaine packets.
Axial abdominal LDCT shows numerous hypodense packets inside the stomach (arrowheads), with a mean density of 27 HU.
Laboratory analyses showed a cocaine concentration of 28.6%; the calculated compaction was 0.8 g/cm^3.

The continuous variables of compaction and cocaine content were dichotomized in order to facilitate interpretation. The threshold was selected based on a preliminary analysis, where these variables were divided into four groups. For cocaine content, the thresholds were 30%, 50%, and 70%; for compaction they were 0.9 g/cm^3, 1.0 g/cm^3, and 1.1 g/cm^3. The thresholds of 50% for cocaine content and 0.9 g/cm^3 for compaction were chosen for providing the best contrast in terms of radiodensity (> 40 HU).

Univariate and multivariate analyses were performed to determine the parameters associated with packet hyperdensity, defined as a density > 40 HU. The threshold for statistical significance was set at $p < 0.05$.

3. Results

3.1. Study population

LDCT revealed 85 suspects to be carrying intestinal drug packets. We excluded 39 from our analyses due to the packets being dissimilar (n = 18) or the chemical analysis being unavailable (n = 21).

Our study group finally comprised 46 cocaine body-packers: five