Detection of ingested cocaine-filled packets: comparison of filtered back projection CT with adaptive statistical iterative reconstructed images

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Purpose

We nowadays observe a steadily increasing worldwide abuse of cocaine with medico legal and social consequences. To smuggle and hide these narcotics the gastrointestinal (GI) tract is often being used as a vehicle (1).

The terms used for intracorporeal concealment of illicit drugs are « body packer », « body pusher » and « body stuffer » (2-4).

Body packers swallow large bags (2-8cm) prior to cross international borders, in order to retrieve them after arrival. They are professional dealers with the main goal to transport narcotics over long distances, thus also called mules (2-4). Body pushers are regional smugglers who hide several drug-filled packets in the vagina or in the rectum (2). Body stuffers, also called «mini packers», are usually local street dealers, who swallow one or several little cocaine-filled packets (CFP) (8-10 mm, Fig. 1, (5)) in order to conceal this small amount of cocaine by fear of police's arrest.

In the daily practice unenhanced abdominal MDCT is increasingly being performed for body stuffers' management mainly indicated by legal purposes, but also for medical reasons, since the leakage of CFP can trigger lethal complications (4-7). However, MDCT is associated with a higher radiation dose than conventional abdominal radiography which remains the established imaging modality for the investigation of body packers (8). Nevertheless, the latter generally incorporate bigger, thus more easily detected packets of narcotics than body stuffers do.

To our knowledge, the diagnostic value of MDCT for the detection of small CFP in body stuffers has not yet been exactly evaluated, especially in comparison with a real reference standard.

Thus, the purpose of our study was

- To assess the diagnostic value of abdominal MDCT performed in body stuffers for the detection of ingested CFP

- To compare the technical quality of the images, in terms of spatial and contrast resolution and artefacts, as well as the diagnostic value of axial MDCT obtained by filtered back projection (FBP) with adaptive statistical iterative images (30% ASIR and 60% ASIR) concerning body stuffers with ingested CFP
Fig. 1: Typical appearance of a cocaine-filled packet, wrapped in several layers of cellophane, which hardly measures 1.4cm in diameter.

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Methods and Materials

Patients

We prospectively included 29 body stuffers admitted by the police to the emergency department from August 2009 to November 2010 because of suspected ingestion of CFP (mean age 31.9 years, 3 women).

In 13 (44.83%) out of them cocaine-filled packets were detected in the digestive tract. Their number (range 1-25 per body stuffer) was then confirmed by a member of the emergency staff who had to collect and exactly analyse the faeces evacuated after the CT. Only after elimination of all the CFP detected on CT the body stuffers could be discharged. The body stuffers were subjected to continuous medical surveillance, because of the large dose of cocaine situated in the digestive tract, but none of the packets ruptured.

CT image acquisition

Twenty-nine body stuffers were examined on a 64 row multidetector CT (Lightspeed Ultra, GE Healthcare, Milwaukee, Wisconsin, USA). We performed a routine acquisition including the whole digestive tract (120kV, pitch 1.375, 100-300 mA and automatic tube current modulation in x-, y- and z-axis(auto mA), noise index (NI) 10 UH, rotation time 0.7sec and collimation 2.5mm) without any intravenous neither intestinal contrast medium administration. Primary axial images were obtained with FBP technique, followed by axial images with 30% and 60% ASIR. The radiation dose necessary for the MDCT data acquisition was about 600 mGy.cm (range 247-648) corresponding to approximatively 9 mSv.

CT image analysis

After an introductory and explanatory session, four abdominal radiologists (with 5-20 years of experience in emergency radiology) blindly and separately read the 87 anonymous CT (29 FBP-CT and 58 ASIR-CT (among them twenty-nine 30% ASIR-CT and twenty-nine 60% ASIR-CT) examinations on workstations complying with the DICOM 3.14 standard.

All radiologists had been previously taught to use the lung kernel instead of the usual soft tissue kernel for image analysis in order to better detect the typical image of
ingested CFP, which is an outer thin hypodense halo of air trapped within the cellophane surrounding a dense, sometimes even hyperdense structure. (5) (Fig. 2)

The four readers had to analyse each CT examination regarding the following points:

a. Subjective evaluation (five levels) of the overall image quality

b. Subjective evaluation (three levels) of the spatial resolution of a sharp structure, defined as one of the two adrenal glands

c. Measurement of the density of the psoas muscle including the standard deviation by means of a region of interest (ROI) with a size of 200-300 mm$^2$

d. Measurement of the density of a fluid-containing organ (gall-bladder or, if absent, bladder) including the standard deviation by means of a ROI with a size or 200-300mm$^2$

e. Identification of the common bile duct (visible or not visible)

f. Detection of intestinal cocaine-filled packets including their number and their exact localisation in the gastrointestinal tract with the estimation of the diagnostic certitude (three levels)

g. Estimation time of reading of the whole CT
Fig. 2: Axial unenhanced CT images in soft tissue kernel (A) did not allow such a straightforward identification of the two rectal cocaine-filled packets than the lung kernel (B) because of far more difficult visualization of the outer hypodense thin halo corresponding to a small amount of air trapped within the cellophane.

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Results

The increase of ASIR technique significantly diminished the objective noise measured on the images \((p<0.001)\).

The analysis of adrenal gland \((p=0.206)\) and the identification of the common bile duct \((p=0.450)\) did not depend on the type of image reconstruction (FBP, 30% ASIR or 60% ASIR), neither did the time of reading the examinations \((p=0.901)\).

The overall sensitivity and specificity of all four readers for the detection of cocaine-filled packets (without taking account of the exact number) was 91.1% and 84.8%, respectively \((\text{Fig. 3, Fig. 4})\). The area Az under the ROC curve was 0.92. The individual results can be seen in **Table 1**, the result obtained for the differently reconstructed images (FBP, 30% ASIR, 60% ASIR) is demonstrated in **Table 2**.

**Table 1**

Diagnostic value of the 4 readers concerning the detection (absence/presence) of cocaine-filled packets in the digestive tract

<table>
<thead>
<tr>
<th></th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
<th>Area Az (ROC curve)</th>
</tr>
</thead>
<tbody>
<tr>
<td>L 1</td>
<td>100</td>
<td>100</td>
<td>1</td>
</tr>
<tr>
<td>L 2</td>
<td>90.7</td>
<td>90.7</td>
<td>0.953</td>
</tr>
<tr>
<td>L 3</td>
<td>88.9</td>
<td>75.2</td>
<td>0.876</td>
</tr>
<tr>
<td>L 4</td>
<td>85.0</td>
<td>74.4</td>
<td>0.871</td>
</tr>
</tbody>
</table>

**Table 2**

Diagnostic value of the three types of reconstructed images concerning the detection (absence/presence) of cocaine-filled packets in the digestive tract

<table>
<thead>
<tr>
<th></th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
<th>Area Az (ROC curve)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FBP</td>
<td>92.3</td>
<td>86.1</td>
<td>0.930</td>
</tr>
<tr>
<td>30% ASIR</td>
<td>90.6</td>
<td>84.2</td>
<td>0.921</td>
</tr>
<tr>
<td>60% ASIR</td>
<td>90.6</td>
<td>84.2</td>
<td>0.921</td>
</tr>
</tbody>
</table>

FBP = filtered-back projection, ASIR = adaptive statistical iterative reconstructions
There was no significant difference in sensitivity or specificity between the three types of reconstructed images \( (p=0.333, \text{ Table 2}) \).

The readers’ \textbf{diagnostic certitude}, estimated when reading the images, did not significantly vary between the three types of reconstructed images \( (p=0.891) \).

Concerning the number of cocaine-filled packets located in the digestive tract, model-based linear regression showed a \textbf{prediction of 93.35\%} for detecting the correct number of CFP. The \textbf{interobserver agreement kappa} between the four readers to detect the correct number and position of the CFP varied from \textbf{0.51 to 0.79 (mean = 0.62)}, thus considered as good according to Fleiss (8).
Images for this section:

**Fig. 3:** Axial unenhanced CT images reconstructed with FBP or ASIR 0 (left), ASIR 30% (middle) and ASIR 60% (right) uniformly show a small cocaine-filled packet located in a small bowel segment (arrow). No significant difference in the diagnostic quality between the three images is visible. This CFP had only been detected by two out of our four readers; both depicted it on each type of reconstruction. The other two radiologists who failed to detect it, did not see it on any of the three reconstructed images, which also seems to confirm their similar diagnostic quality.

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**Fig. 4:** Axial unenhanced abdominal MDCT images in lung kernel (A-C) show several small hyperdense nodules located in the recto sigmoid colon which seem to be surrounded by a thin, hypodense rim, thus simulating small cocaine-filled packets (CFP). However, the search of the faeces of this body stuffer turned out to be negative. Thus, the image corresponds probably to undigested, possibly calcified, residual food. Two of our four readers interpreted these images as positive for CFP.

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Conclusion

1. Our study confirms that unenhanced MDCT is a useful and reproducible imaging modality for the detection and count of small ingested cocaine-filled packets (1-2cm). Nevertheless, MDCT always needs to be interpreted with caution, since several pitfalls exist. As to our knowledge, we have been the first working group comparing the CT results with the real standard of reference, which is the proof of the detected number of CFP by faecal analysis.

2. Our images with 30% and 60% ASIR allowed for a significant noise reduction compared to the initial FBP technique by "smoothing" of the images that may decrease the diagnostic quality. However, our study showed that the sensitivity and specificity for detecting CFP did not change significantly. These results point out that we can reduce the radiation dose significantly (≤ 40%) in these mostly young people without any risk of decreasing the diagnostic quality.
References

Personal Information

This prospective study has been performed by the department of diagnostic and interventional radiology of the University Hospital of Lausanne, Switzerland.