Is abdominal radiography still adapted for the screening of illegal intra-corporeal containers ("body-packing")? A comparative study with low-dose CT

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Is abdominal radiography still adapted for the screening of illegal intra-corporeal containers ("body-packing")? A comparative study with low-dose CT

Original research

Advances in knowledge:

1) Abdominal radiography (AR) achieves a limited sensitivity (77%) for the screening of illegal intra-corporeal containers when compared to low-dose CT

2) Illegal intra-corporeal packets are difficult to detect by AR when they are in small number (< 12)

3) The sensitivity of AR for detection of illegal intra-corporeal containers is lower (50%) when they appear iso-dense to the bowel content at low-dose CT than when they appear denser (89%).

Implications for patient care:

Performing low-dose CT instead of AR will improve the detection of illegal intra-corporeal packets, without increasing the radiation dose.

Summary statement:

The use of low-dose CT may constitute a reasonable alternative to abdominal radiography to improve the detection of illegal intra-abdominal packets

Abstract

Purpose: To evaluate the diagnostic performance of the abdominal radiography (AR) to a low-dose CT (LDCT) in the detection of illegal intra-corporeal containers ("packets") using LDCT as a reference standard.

Materials and Methods: This study was approved by the institutional ethical review board ; a written informed consent was required (CER 06-023).

330 consecutive persons, suspected of having ingested drug packets, underwent a supine AR. The presence or absence of packets at AR were reported and compared to the result of LDCT , considered reference standard. The density and the number of packets ($\leq$12 or above) at LDCT were recorded and analyzed to determine if they may influence the AR interpretation.

Results: Packets were detected at LDCT in 53 (16%) suspects. The sensitivity of AR for depiction of packets was 77% (41/53), the specificity 96% (267/277). The packets appeared iso-dense to the bowel contents on LDCT in sixteen (30%) of the 53 positive cases. Nineteen (36%) of the 53 positive LDCT displayed fewer than 12 packets. Iso-dense packets on LDCT and having a low number of packets ($\leq$12) were both significantly associated with false negative AR exams.

Conclusion: AR is mainly limited by a low sensitivity when compared to LDCT for the screening of persons suspected of carrying drug packets. LDCT constitutes an efficient imaging alternative to AR.

Introduction

The management of persons suspected of having swallowed drug containers is a complex procedure, which usually integrates the results of specific investigations (1, 2). Once a person has been suspected of carrying intra-corporeal drug containers, he (or she) is usually referred to a medical center to undergo a radiological examination. Usually, this examination consists in an abdominal radiography (AR), which is used to confirm or infirm the prior suspicion and, thus, to determine whether or not a stool analysis will be required (3-5). However, the value of the AR for the screening for intracorporeal containers has never been prospectively evaluated in a large series of suspects, using the CT as reference standard. Indeed, in spite of the fact that the CT has been reported to be the most accurate imaging method for displaying intra-abdominal containers (6-11), the dose of radiation typically delivered using this technique is a major limitation in its systematic use to screen persons suspected of conveying illegal intra-corporeal drug containers. This concern can now be overcome by the use of low-dose CT protocols, which deliver a dose of radiation close to that of an AR. These low-dose CT protocols have been reported to be accurate for the screening of well defined medical conditions, such as renal colic (12) and appendicitis (13-15) and have also been recently reported a useful in demonstrating the presence of an intracorporeal drug packet (16, 17).

The purpose of this study is to evaluate the diagnostic performance of the abdominal radiography (AR) to a low-dose CT (LDCT) in the detection of illegal intra-corporeal containers (“packets”) using low-dose CT as a reference standard.

Materials and Methods

This research was approved by the Research Ethics Committee of our institution (CER 06-023) ; written informed consent was obtained. During the study period (July 2007 to July 2010), all consecutive adult persons suspected of having ingested drug packets within the State territory (n=338) were systematically brought to our emergency department, at any time of the day or the night, instead of being dispatched in various medical institutions to undergo an AR.

Immediately after admission in our emergency radiology unit, suspects underwent a supine AR. The AR was immediately interpreted by the radiologist on call (a fellow or a senior resident). The prior training for a fellow (respectively a senior resident) was 5 to 6 years of general radiology (respectively 3 to 5 years), including at least 6 months of conventional radiology and 2 years of body CT. Twenty-two fellows or senior residents did participate to the AR and LDCT reading during the study period. The radiologist on call had to report on a standardized electronic form whether AR was considered positive or negative for the presence of packets. An AR was considered positive for the presence of packet(s), when at least one of the following criteria was present (18): 1) one or multiple well defined densities in the stomach, small bowel and/or colon, not suggestive of alimentary content 2) a "double condom sign" (Fig. 1), defined as a definite crescent of air surrounding an ovoid density (3), 3) a smooth and uniformly shaped oblong structure (sometimes referred to as the "tic-tac" sign (18)) 4) the "parallelism sign", defined as "rigid packages aligning parallel to each other in the bowel lumen"(18). The radiologist was also asked to report the degree of confidence in the AR interpretation, for the presence or absence of packets, on a scale from 1 to 4 (1= minimal confidence in the diagnosis, 2 = moderate confidence, 3= good confidence, 4= excellent confidence). The suspect's BMI was also recorded.

Once the AR was interpreted, the suspect underwent an abdominal LDCT which was also immediately interpreted as positive or negative for the presence of packets by the same radiologist. The interpretation of LDCT was also reported on an electronic form. The radiologist had to indicate

whether the number of foreign bodies depicted on LDCT was less or equal to 12 (Fig. 2) or greater. The visual aspect of the packets at LDCT was reported as iso-dense (Fig. 3) or hyper-dense with regard to the intestinal content.

A brief report, just indicating the presence or absence of packets at both AR and LDCT, was given to the police or boarder guard authorities.

Reference standards

LDCT was considered reference standard. When LDCT was negative, no further examination was performed and the suspect left the hospital. When LDCT was positive, the suspect was hospitalized in a dedicated ward of our institution and kept under surveillance for stool analysis. All collected packets were handed over to a dedicated laboratory for chemical characterization of the content.

Exclusion criteria

Persons who refused to participate in the study, those under 18 year of age and pregnant women, were excluded from the current survey. They usually underwent a stool analysis. A pregnancy test was systematically obtained in every woman of childbearing age.

Technical imaging parameters

ARs were performed with the patient in the supine position using an X-Ray Philips Optimus 65 unit with automatic exposure control (Philips Medical Systems, Best, the Netherlands).

LDCT were performed with a 16-row Philips MX 8000 (Philips Medical Systems, Best, the Netherlands), from lung bases to pelvis, without administration of oral or rectal contrast material, using the following parameters: 16x1.5 mm collimation, pitch 1.25, gantry rotation period 0.5 second, tube potential 120 kV, tube charge per gantry rotation 30 mAs (75 mA x 0.5 s / 1.25 = 30 mAs), reconstruction slice thickness 3.0 mm.

Effective dose calculation

1. AR

For a field of 35 x 43 cm, the entrance doses delivered by the AR were 6.0 mGy (66 kV and 50 mA) to 12 mGy (73 kV and 120 mA), with an average of 9 ±3.0 mGy. The effective doses (E) were computed using ODS 60 software(19); for women, E= 2.0 ±0.7 mSv and for men, E=1.3 ±0.4 mSv.

2. LDCT

The dose delivered by LDCT was estimated using the ImPACT CT patient dosimetry calculator (20), using the default nCTDIw of 7.0 mGy/100 mAs proposed at 120 kV (value compatible with our measurements within 10%). The following results were provided by the program: DLP (women) = 84±10.5 mGy cm; E (women) = 1.7±0.2 mSv. DLP (men) = 84±10.5 mGy cm; E (men) = 1.2±0.1 mSv.

Statistical analysis

AR were compared to LDCT used as reference standard to estimate the sensitivity, the specificity, the positive predictive value (PPV) and the negative predictive value (NPV) for depiction of foreign bodies in the whole study population (n=330). The 95% confidence intervals of these statistics were estimated with the Clopper-Pearson method.

The radiologist's confidence in the AR analysis was considered as an ordinal variable consisting in a 8 level scale, from negative AR with a level of confidence of 4 (level 1) to a positive AR with confidence level of 4 (level 8). A ROC curve was obtained. The optimal cut-off on the level of confidence of the radiologist was determined by maximising Youden's index (sensitivity + specificity -1)(21). Likelihood ratios (LR) were used to assess how informative were the levels of confidence given by the radiologists.

Considering the positive cases at LDCT only, a logistic regression model was obtained to test the influence of the conveyers' BMI (< 25 or ≥25), of the density and of the quantity of the packets on their detection on the AR. Furthermore, sensitivities were computed on the strata defined by the density (iso-dense versus hyper-dense) and the quantity (below 12 versus above 12) of the packets. The significance level was fixed to 5% (two-tailed). Differences between two groups were tested with t-test for continuous variables and with Fisher's exact test for proportions. All analyses were performed using R for Windows (version 2.13.0)

Results

Population and packets characteristics

Three hundred thirty-eight suspects were brought in our institution during the study period. Eight were excluded from the study because they refused to participate (n=6) or because they were pregnant (n=2). Thus, 330 suspects were included in our protocol, 296 (90%) men and 34 (10%) women, with a mean age of 32 years (range: 18 to 55). BMI was reported under 18.5 (underweight) in 22 (7%) suspects, between 18.5 and 25 (normal range) in 258 (78%), between 25 and 30 (overweight) in 44 (13%), and over 30 (obesity) in 6 (2%). Packets were detected by LDCT, and found at stool analysis, in 53 (16%) of the 330 suspects.

In 50 (94%) of the 53 true positive cases, packets content consisted of cocaine-hydrochlorate powder (also containing various cutting agents such as phenacetin), weighting between 7 and 25 grams each (mean 10.6 grams). In three persons, packets contained rolls of banknotes, wrapped in cellophane bags. Packets were located in the bowel or rectum (n=51) or in the vagina (n=2, 8 packets of drug in one, banknotes in the other). Twelve (23%) of the 53 drug conveyers carried between 1 and 6 packets, 7 (13%) between 7 and 12 packets, and 34 (64%) had more than 12 packets.

AR versus LDCT

The presence of packets was suspected by the radiologists at AR in 51 (15%) of the 330 suspects. When compared to LDCT, 41 AR were true positive, 10 false positive, 267 true negative, 12 false negative. The sensitivity, specificity, PPV and NPV of AR are reported in Table 1.

Confidence of the radiologist in his/her AR interpretation

The degree of confidence in the interpretation was equal to 1 in 17 (5%) of the 330 suspects, 2 in 86 (26%), 3 in 164 (50%) and 4 in 63 (19%). The ROC curve associated with confidence in the AR analysis considered as an ordinal 8-level variable showed good discrimination (Fig. 4), as the area under the ROC curve was 0.95. The optimal sensitivity and specificity (85% and 94% respectively) are obtained at the cut-off point of 4, when a negative result with a level of confidence of 1 is considered as a "positive" result. This cut point leads to a PPV of 74% (45/61) and to a NPV of 97% (261/269).

Table 2 shows the likelihood ratios with regard to the degree of confidence in the AR interpretation. In this chart, level 1 and level 2 of confidence have been merged as low confidence, level 3 and 4 as high confidence. Under these conditions, a strong LR (greater than 10 or lower than 1/10) was only achieved, for positive or negative AR, when the confidence was high.

Influence of the conveyers' BMI, of the density and of the quantity of the packets on the AR interpretation.

Among the 53 persons who carried packets, 43 had a BMI below 25 and 10 above 25 (including one above 30). The packets' content was reported iso-dense compared to the bowel content on the LDCT in 16 (30%) of the 53 positive cases, and hyper-dense in 37 (70%). Nineteen conveyers carried 12 or less packets, 34 more than 12. Results of univariate logistic regression (Table 3) showed a non-significant association between BMI >25 and a correct positive identification, but the packets' density and quantity were strongly and significantly associated with true positive status.

The multivariate model confirmed these findings: packets were more difficult to detect when they were iso-dense and/or fewer than 12.

The sensitivity of AR for depiction of packets with regard to their number and their density found at LDCT is reported in Table 4. The highest sensitivity (92%, 24/26) of AR was achieved in the presence of multiple (>12) packets of high density. The lowest sensitivity (25%, 2/8) was found in the presence of a small number of packets ($\leq$12) of a low density.

Discussion

This study aimed to assess the value of AR for the screening of the body-packers, when compared to LDCT. Although some reports have already stressed the limitations of the AR in this setting (2, 6, 7, 22, 23), the diagnostic performance of the AR for identification of illegal packets remained uncertain, due to the absence of a systematic reference standard in the prior reports. Indeed, no prior series systematically included a CT examination or a stool analysis in every suspect after the AR was reported negative. The lack of a straightforward reference standard explains the wide range of sensitivities (from 40% to 100%) that have been previously reported for the detection of intra-corporeal containers by AR (3, 7, 22, 24). In our prospective study, AR achieved an overall 77% (41/53) sensitivity and 96% (267/277) specificity for depiction of packets, when compared to LDCT, systematically obtained in every suspect. Our results show that this technique is mainly limited by a high percentage (23%, 12/53) of false negative cases. Hence, the diagnostic value of AR for the screening of drug conveyers is probably overestimated, and raises questions about its exact role and its limitations in this application. Beside, using AR as sole screening test would have led to falsely consider 4% (10/277) of innocent suspects as positive.

Our data showed that the value of AR is closely related to the confidence of the radiologist in his/her interpretation. High levels of confidence (3 or 4) were associated with high likelihood ratios, while low levels (1 or 2) were not. This observation suggests that an AR cannot be relied on for the detection of packets when the radiologist is not confident in his/her interpretation, which

corresponds, in the current series, to 31% (104/330) of our study group. In such situations, an AR should ideally be completed by a LDCT. However, a CT-scanner is not always available after the AR has been performed, especially when the screening is not performed in a medical system (but, for instance, within a remote airport). Beside, the additional cost of an unenhanced CT examination (about 3 to 4 times the price of an AR) often precludes its systematic use in this setting. When the screening of body-packers must be based on AR alone, our results (ROC curve) showed that the optimal ratio for sensitivity (85%) and specificity (94%) is obtained by considering a negative AR with a lower level of confidence (1 of 4) as positive result (cut-off point). Doing so will still lead to a 15% rate of false negative and a 6% rate of false positive AR. Our results did not show any relationship between the suspects' BMI and the AR results. However, the group of overweight body-packers (BMI $\geq$25) only included 1 obese person (BMI> 30); it is therefore impossible to draw any conclusion with regard to this specific sub-group.

The last objective of the study was to retrospectively determine whether the apparent density of the packets at LDCT and/or their quantity might influence their detectability at AR. Our results showed that the density and the number of the packets at LDCT were significantly correlated to the rate of false negative readings, at both univariate and multivariate analysis. The association between the radiological attenuation of various drugs and their possible presentations (powder, stones, tablets, pills etc..) has already been reported in extra-corporeal analyses (5).

The fact that the sensitivity of the AR was only 50% (8/16) in suspects carrying iso-dense packets, when compared to 89% (33/37) in those carrying dense containers, suggests that the increased X-ray attenuation constitutes a major radiological sign for their detection at AR. Furthermore the sensitivity dropped to 25% (2/8) when packets were both iso-dense and in small quantity ($\leq$ 12). With the improvement in the packets manufacturing, it would not be surprising if a majority of intra-corporeal containers became undetectable at AR in a short time span. This supposition is bolstered by recent reports of incidental seizure of liquid or mushy forms of intra-abdominal

concealed cocaine packets, that remained absolutely undetectable at AR, even at retrospective analysis(25).

Our study had a number of limitations. In the current series, packets consisted exclusively in large "finger like" containers from 7 to 25 grams each. Therefore, our data can certainly not be transposed to a population of smugglers using smaller drug packets, sometimes referred to as "body-stuffers" or "mini-packers" (10). In the latter situation, it is possible that the AR interpretation would have led to a higher rate of false negative interpretations.

Similarly, in the current study, intra-corporeal containers contained only cocaine-hydrochlorate powder (along with cutting agents), and banknotes in three cases, which is linked to the local trends in drug trafficking. Whether our results can be extrapolated to other packets content (such as heroin or liquid cocaine) remains an open question.

Finally, the methodology of the current series was based on the postulate that LDCT is a reference standard for detection of intra-corporeal containers. However, no prior study has yet evaluated a negative LDCT (or even a standard CT) with a systematic stool analysis. Since the sensitivity of LDCT for detection of intra-abdominal packets is unknown, it can therefore not be completely excluded that some intra-corporeal containers may have been missed by both AR and LDCT. Nevertheless, our study results demonstrated the high specificity of LDCT in this setting; indeed, all positive LDCTs of our study population were confirmed by stool analysis without any report of false positive cases.

In conclusion, the current study shows that the detection of illegal intra-abdominal containers by AR is related to their X-Ray attenuation and to their quantity. The interpretation of AR should take into consideration the level of confidence of the radiologist in his/her interpretation to optimize both sensitivity and specificity. The use of LDCT may constitute a reasonable alternative to AR to improve the detection of illegal intra-abdominal packets

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Table 1 Evaluation of abdominal radiography for detection of body-packs, using low-dose CT as reference standard

	Estimated Value	95 % Confidence Interval
Sensitivity	41/53 = 0.77	0.64 – 0.88
Specificity	267/277 = 0.96	0.93 – 0.98
Positive predictive value	41/51 = 0.80	0.67 – 0.90
Negative predictive value	267/279 = 0.96	0.93 – 0.98

Table 2 Results of the abdominal radiography (AR) interpretation according to the confidence of the radiologist in his/her interpretation, when using low-dose CT (LDCT) as reference standard

	Positive LDCT	Negative LDCT	Likelihood Ratio[3]
Negative AR High confidence [1]	2 (3.8%)	187 (67.5%)	0.06
Negative AR Low confidence [2]	10 (18.9%)	80 (28.9%)	0.65
Positive AR Low confidence	5 (9.4%)	8 (2.9%)	3.27
Positive AR High confidence	36 (67.9%)	2 (0.7%)	94.08
Total	53 (100%)	277 (100%)	

(1) High confidence: reported 3 or 4 on a 4 level scale (2) Low confidence : reported 1 or 2 on a 4 level scale (3) A strong likelihood ratio is considered when greater than 10 or below 1/10

Table 3 Association between the suspect's body mass index (BMI), the quantity and the density of the packets and their detection at abdominal radiography when compared to low-dose CT (reference standard)

		Univariate		Multivariate	
		Odds Ratio (95% CI)	p-value	Odds Ratio (95% CI)	p-value
BMI	< 25(1)	1			
	≥ 25	3.1 (0.4-27.3)	0.31		
Density	Iso-dense(1)	1		1	
	Hyper-dense	8.3 (2.0-34.4)	0.004	7.5 (1.6-33.7)	0.009
Quantity	≤ 12(1)	1		1	
	> 12	5.5 (1.4-21.8)	0.016	4.8 (1.1-21.9)	0.042

(1) Reference level for comparison

Table 4 Sensitivity of abdominal radiography for depiction of intracorporeal packets with regard to their quantity and density at low-dose CT

		N	Sensitivity
Density			
	Iso density	8/16	0.50 (0.25-0.75)
	High density	33/37	0.89 (0.75-0.97)
Quantity			
	≤12 packets	11/19	0.58 (0.33-0.80)
	>12 packets	30/34	0.89 (0.73-0.97)
Both variables			
	Iso density ≤12 packets	2/8	0.25 (0.03-0.65)
	Iso density >12 packets	6/8	0.75 (0.35-0.97)
	High density ≤12 packets	9/11	0.82 (0.48-0.98)
	High density >12 packets	24/26	0.92 (0.75-0.99)

Number between parentheses are 95% CI

FIGURE CAPTIONS

Figure 1

True positive abdominal radiography (AR) in a 30 year-old man suspected of conveying drug packets.

Admission AR (a) shows multiple well defined smooth and uniformly shaped oblong densities (asterisks) spread throughout the abdomen, not suggestive of alimentary content, with peripheral crescent of air or "double condom sign" (arrow), consistent with drug packets. The radiologist on call did report this AR as positive, with a very high confidence (4/4) in his diagnosis.
Axial (b) low-dose CT images shows a large quantity (>12) of intra-intestinal packets, hyper-dense to the surrounding bowel content. Eighty containers stuffed with cocaine were found at stool analysis (c).

Figure 2

False negative abdominal radiography (AR) in a 26 year-old man, suspected of conveying drug packets.

Admission AR (a) was initially reported as negative by the radiologist on call, with a low degree of confidence (1/4) in his diagnosis.
Axial (b) and sagittal MPR reformatted (c) low-dose CT images, show a small quantity ($\leq$ 12) of packets within the rectum, hyper-dense to the surrounding bowel content (arrow). Six containers stuffed with cocaine were found at stool analysis (d).

Figure 3

False negative abdominal radiography (AR) in a 54 year-old man, suspected of conveying drug packets.

Admission AR (a) was initially reported as negative by the radiologist on call, with a low degree of confidence (1/4) in his diagnosis.
Axial (b) low-dose CT images, shows a large quantity (>12) of packets within the stomach (arrowheads) and the small bowel (arrow), iso-dense to the surrounding gastric and bowel content. Three dozen of containers stuffed with cocaine were found at stool analysis.

Figure 4

ROC curve displaying the sensitivity and specificity of the abdominal radiography (AR) interpretation for the presence of intra-corporeal packets, with regard to the level of confidence of the radiologist in his/her interpretation

Points 1 to 8 correspond to the sensitivity and specificity for depiction of packets if the AR were considered positive at these threshold levels:

Point 1: corresponds to an AR reported as negative by the radiologist, with a high level of confidence (4 of 4)
Point 2: AR reported as negative, level of confidence of 3
Point 3: AR reported as negative, level of confidence of 2
Point 4: AR reported as negative, level of confidence of 1
Point 5: AR reported as positive, level of confidence of 1
Point 6: AR reported as positive, level of confidence of 2
Point 7: AR reported as positive, level of confidence of 3
Point 8: AR reported as positive, level of confidence of 4

The optimal sensitivity and specificity (85% and 94% respectively) are obtained at the cut-off point of 4, when a negative result with a level of confidence of 1 is considered as a positive result.

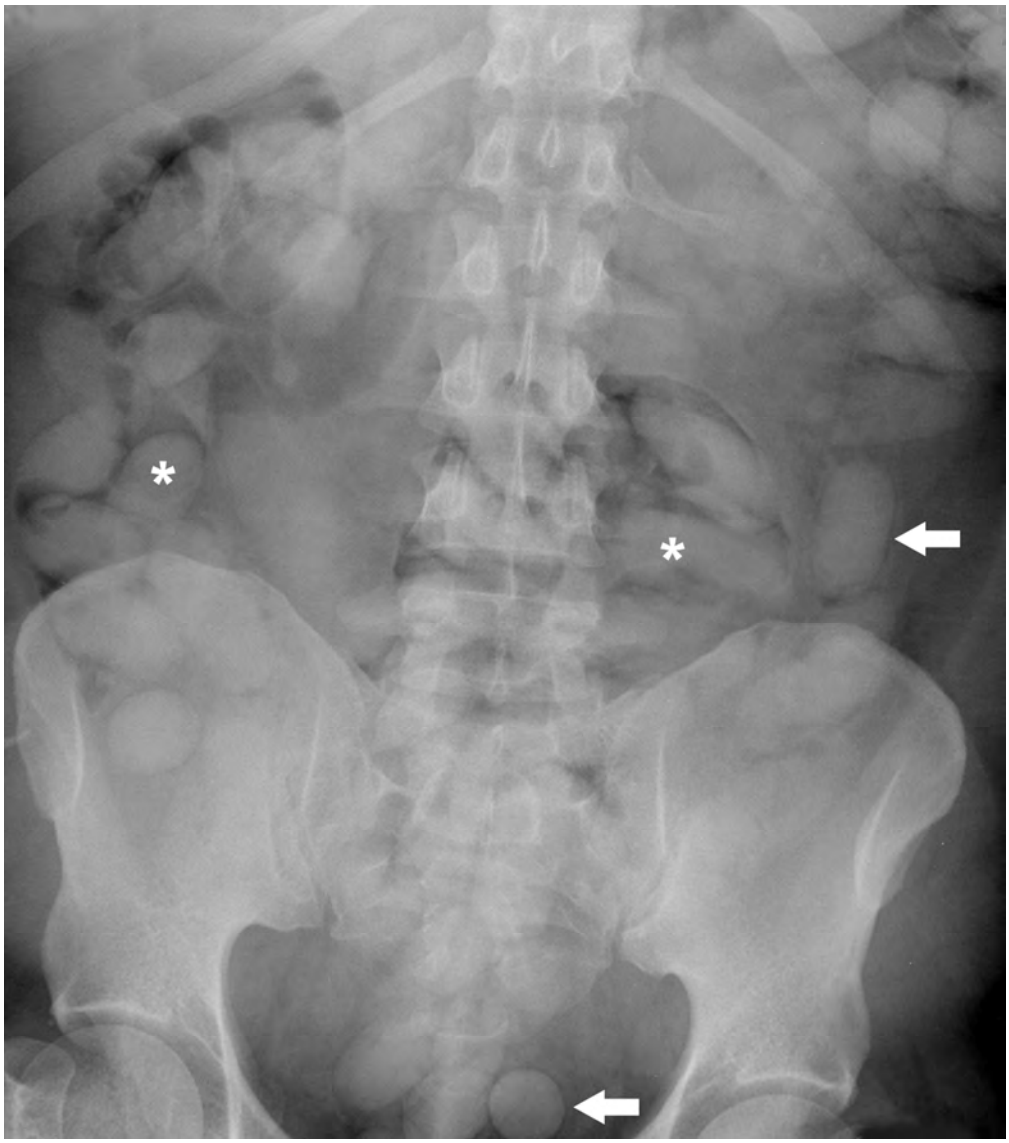

Figure 1a True positive abdominal plain film (APF) in a 30 year-old man suspected of conveying drug packets.

Admission APF (a) shows multiple well defined smooth and uniformly shaped oblong densities (asterisks) spread throughout the abdomen, not suggestive of alimentary content, with peripheral crescent of air or "double condom sign" (arrow), consistent with drug packets. The radiologist on call did report this APF as positive, with a very high confidence (4/4) in his diagnosis.
Axial (b) low-dose CT images shows a large quantity (>12) of intra-intestinal packets, hyper-dense to the surrounding bowel content. Eighty containers stuffed with cocaine were found at stool analysis (c).

103x116mm (300 x 300 DPI)

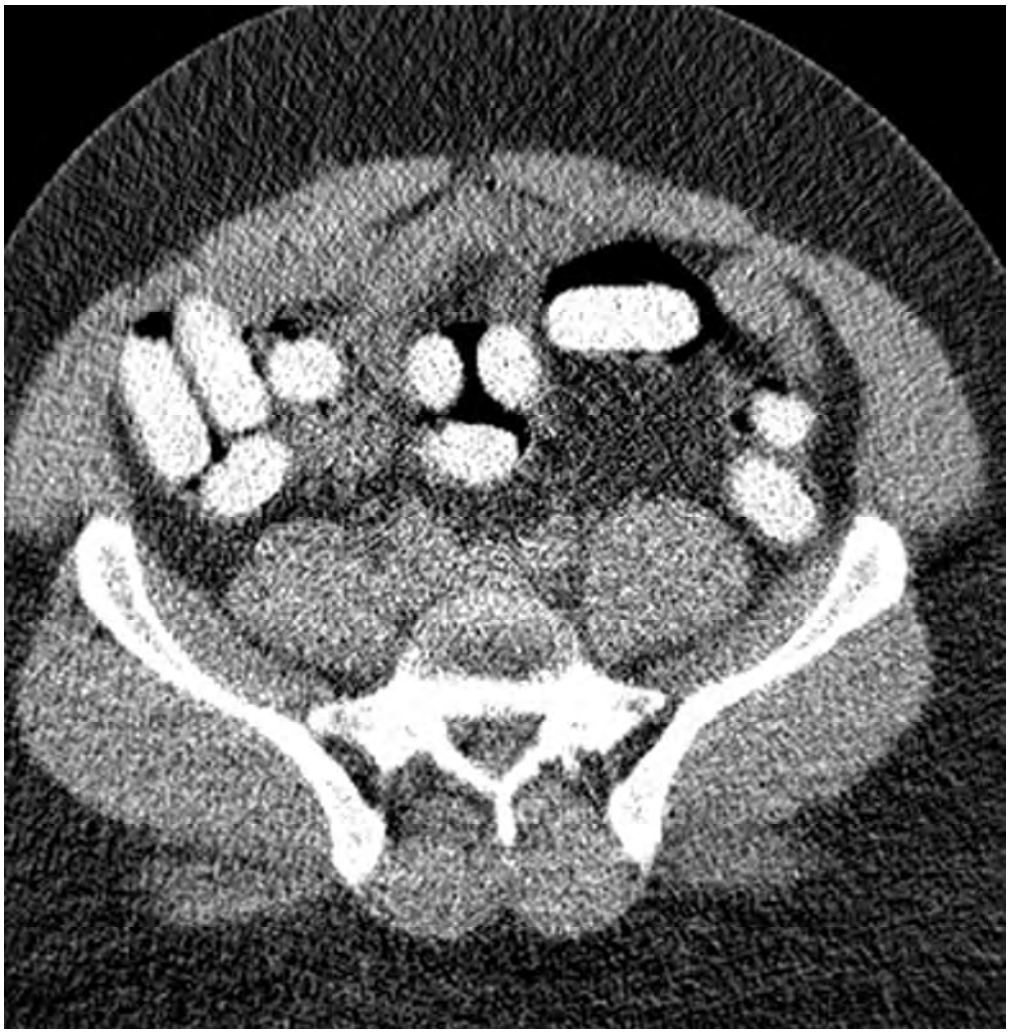

Figure 1b True positive abdominal plain film (APF) in a 30 year-old man suspected of conveying drug packets.

Admission APF (a) shows multiple well defined smooth and uniformly shaped oblong densities (asterisks) spread throughout the abdomen, not suggestive of alimentary content, with peripheral crescent of air or "double condom sign" (arrow), consistent with drug packets. The radiologist on call did report this APF as positive, with a very high confidence (4/4) in his diagnosis.
Axial (b) low-dose CT images shows a large quantity (>12) of intra-intestinal packets, hyper-dense to the surrounding bowel content. Eighty containers stuffed with cocaine were found at stool analysis (c).

117x119mm (300 x 300 DPI)

Figure 1c True positive abdominal plain film (APF) in a 30 year-old man suspected of conveying drug packets.

Admission APF (a) shows multiple well defined smooth and uniformly shaped oblong densities (asterisks) spread throughout the abdomen, not suggestive of alimentary content, with peripheral crescent of air or "double condom sign" (arrow), consistent with drug packets. The radiologist on call did report this APF as positive, with a very high confidence (4/4) in his diagnosis.
Axial (b) low-dose CT images shows a large quantity (>12) of intra-intestinal packets, hyper-dense to the surrounding bowel content. Eighty containers stuffed with cocaine were found at stool analysis (c).

90x33mm (300 x 300 DPI)

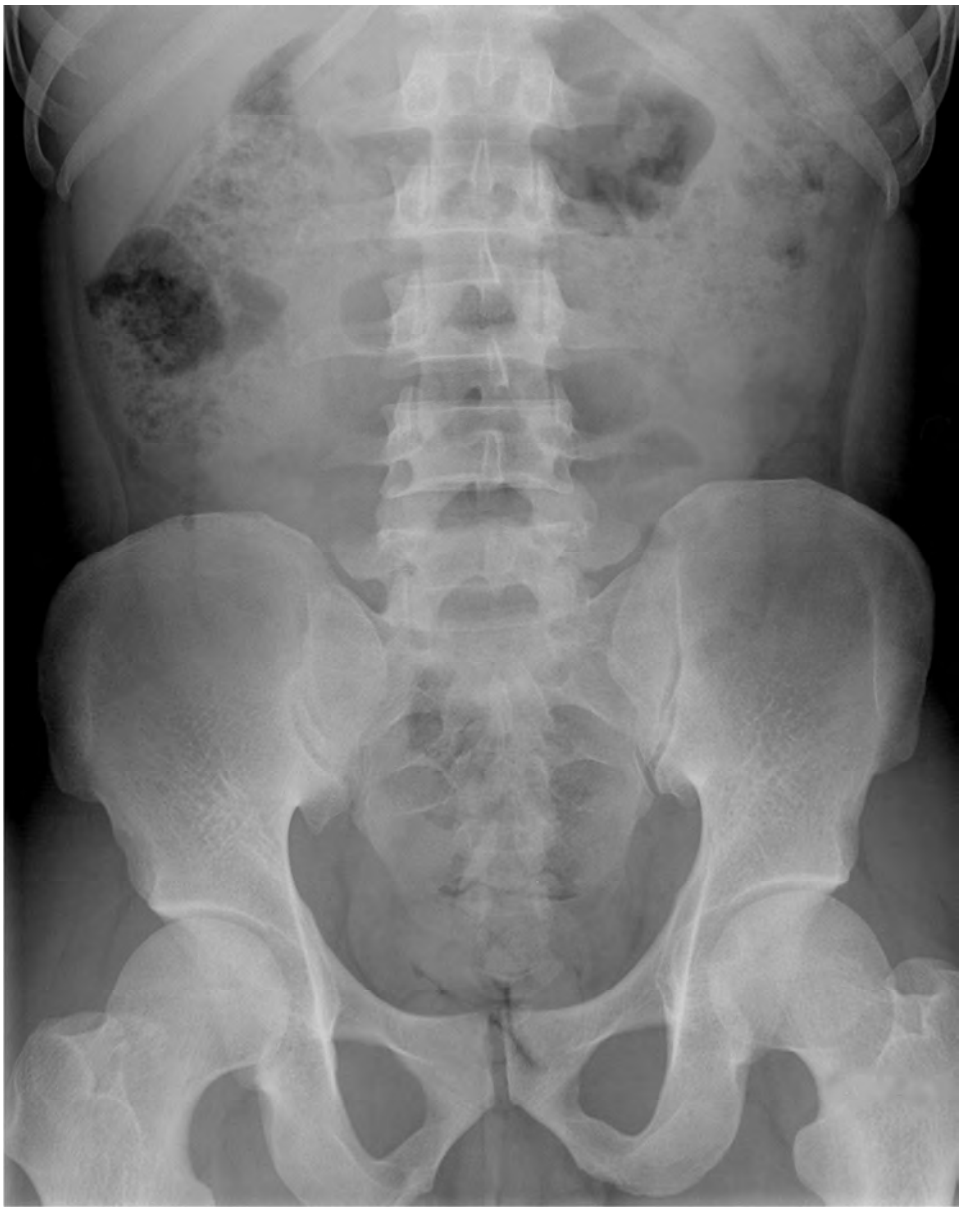

Figure 2a False negative abdominal plain film (APF) in a 26 year-old man, suspected of conveying drug packets.

Admission APF (a) was initially reported as negative by the radiologist on call, with a low degree of confidence (1/4) in his diagnosis.
Axial (b) and sagittal MPR reformatted (c) low-dose CT images, show a small quantity (< 12) of packets within the rectum, hyper-dense to the surrounding bowel content (arrow). Six containers stuffed with cocaine were found at stool analysis (d).

119x150mm (300 x 300 DPI)

Figure 2b False negative abdominal plain film (APF) in a 26 year-old man, suspected of conveying drug packets.

Admission APF (a) was initially reported as negative by the radiologist on call, with a low degree of confidence (1/4) in his diagnosis.
Axial (b) and sagittal MPR reformatted (c) low-dose CT images, show a small quantity (< 12) of packets within the rectum, hyper-dense to the surrounding bowel content (arrow). Six containers stuffed with cocaine were found at stool analysis (d).

119x82mm (300 x 300 DPI)

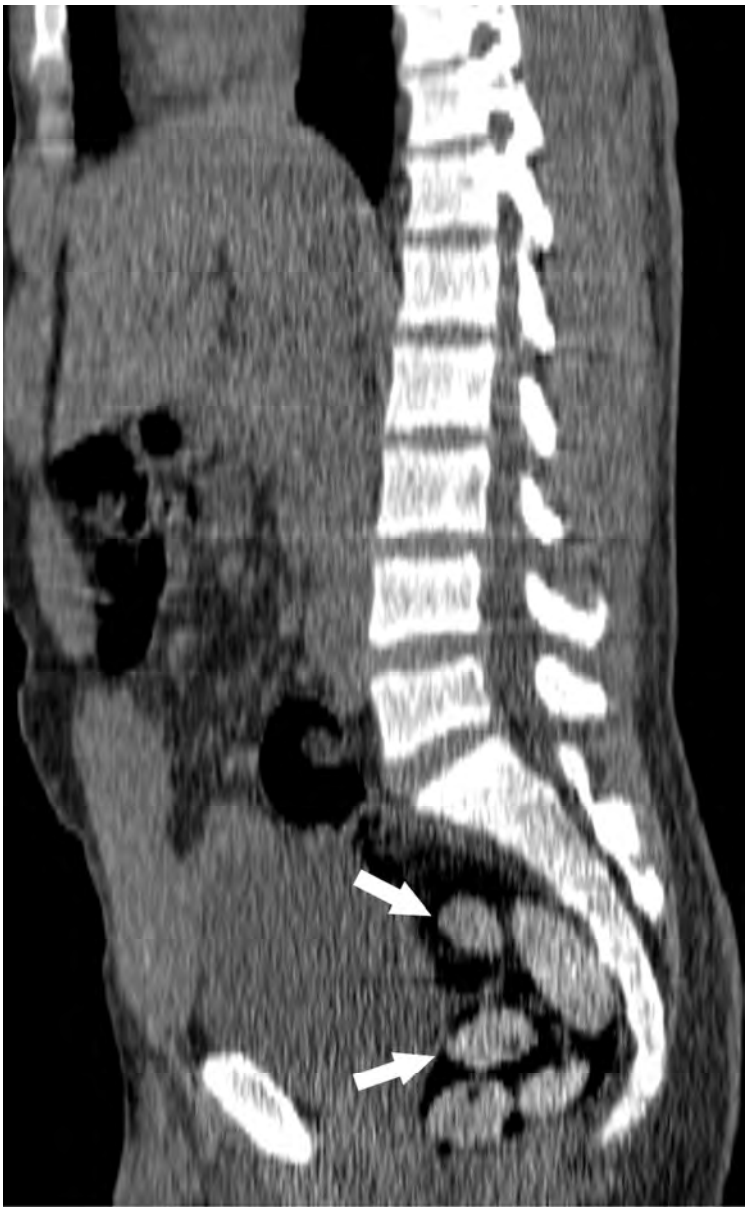

Figure 2c False negative abdominal plain film (APF) in a 26 year-old man, suspected of conveying drug packets.

Admission APF (a) was initially reported as negative by the radiologist on call, with a low degree of confidence (1/4) in his diagnosis.
Axial (b) and sagittal MPR reformatted (c) low-dose CT images, show a small quantity (< 12) of packets within the rectum, hyper-dense to the surrounding bowel content (arrow). Six containers stuffed with cocaine were found at stool analysis (d).

73x119mm (300 x 300 DPI)

Figure 2d False negative abdominal plain film (APF) in a 26 year-old man, suspected of conveying drug packets.

Admission APF (a) was initially reported as negative by the radiologist on call, with a low degree of confidence (1/4) in his diagnosis.
Axial (b) and sagittal MPR reformatted (c) low-dose CT images, show a small quantity (< 12) of packets within the rectum, hyper-dense to the surrounding bowel content (arrow). Six containers stuffed with cocaine were found at stool analysis (d).

106x48mm (300 x 300 DPI)

Figure 3a False negative abdominal plain film (APF) in a 54 year-old man, suspected of conveying drug packets.

Admission APF (a) was initially reported as negative by the radiologist on call, with a low degree of confidence (1/4) in his diagnosis.
Axial (b) low-dose CT images, shows a large quantity (>12) of packets within the stomach (arrowheads) and the small bowel (arrow), iso-dense to the surrounding gastric and bowel content. Three dozen of containers stuffed with cocaine were found at stool analysis.

91x119mm (300 x 300 DPI)

Figure 3b False negative abdominal radiography (AR) in a 54 year-old man, suspected of conveying drug packets.

Admission AR (a) was initially reported as negative by the radiologist on call, with a low degree of confidence (1/4) in his diagnosis.
Axial (b) low-dose CT images, shows a large quantity (>12) of packets within the stomach (arrowheads) and the small bowel (arrow), iso-dense to the surrounding gastric and bowel content. Three dozen of containers stuffed with cocaine were found at stool analysis.

119x93mm (300 x 300 DPI)

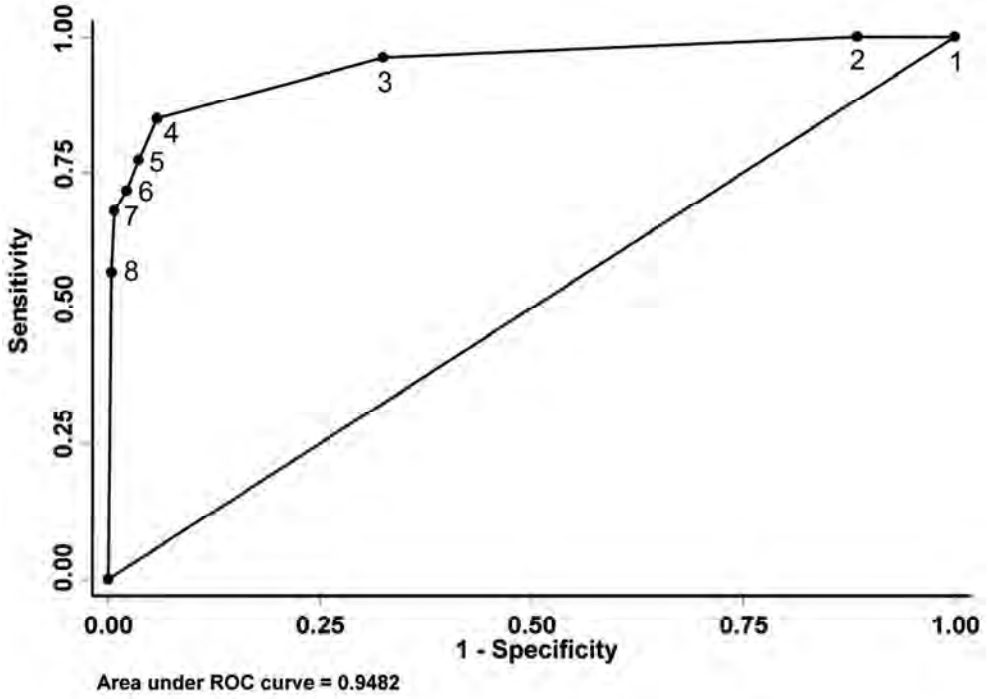

Figure 4 ROC curve displaying the sensitivity and specificity of the abdominal radiography (AR) interpretation for the presence of intra-corporeal packets, with regard to the level of confidence of the radiologist in his/her interpretation

Points 1 to 8 correspond to the sensitivity and specificity for depiction of packets if the AR were considered positive at these threshold levels:

Point 1: corresponds to an AR reported as negative by the radiologist, with a high level of confidence (4 of 4)

Point 2: AR reported as negative, level of confidence of 3

Point 3: AR reported as negative, level of confidence of 2

Point 4: AR reported as negative, level of confidence of 1

Point 5: AR reported as positive, level of confidence of 1

Point 6: AR reported as positive, level of confidence of 2

Point 7: AR reported as positive, level of confidence of 3

Point 8: AR reported as positive, level of confidence of 4

The optimal sensitivity and specificity (85% and 94% respectively) are obtained at the cut-off point of 4, when a negative result with a level of confidence of 1 is considered as a positive result.

58x42mm (600 x 600 DPI)