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CT-guided percutaneous biopsy of suspect pancreatic lesions: radiological and clinical outcome

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AIM: To evaluate the clinical utility of computed tomography (CT)-guided percutaneous biopsies of suspect pancreatic lesions regarding safety, efficiency, radiation dose, intervention time, diagnostic yield, and complications.

MATERIALS AND METHODS: Between 2015 and 2018, 48 patients (18 female, 30 male; mean age: 64.2 years) with suspect pancreatic lesions underwent CT-guided percutaneous biopsy. Ultrasound-guided biopsy of all lesions was not possible or without any result. CT-guided interventions were compared according to the following intervention parameters: radiation dose, procedure duration, number of needle correction scans. Evaluation criteria included technical success as well as major and minor complications according to the Society of Interventional Radiology.

RESULTS: Biopsies were performed successfully in 100% of patients. No major side effects occurred during intervention. As a minor complication, 29.2% showed focal haemorrhage. Seventy-seven percent of lesions had a malignant appearance, and benign inflammatory lesions were found in 23%. The mean size of the target lesions was 2.9 cm (range: 0.7–2.3 cm). The mean target access path within the patient was 8 cm (range: 3–14 cm). The duration to completion was 12 minutes (range: 3 minutes 30 seconds to 30 minutes). The dose–length product of the intervention was 89.5 mGy·cm (range: 11–350 mGy·cm). The average number needle correction scans was 31.1 (range: 6–36).

CONCLUSION: CT-guided biopsy of suspect pancreatic lesions is an efficient and safe method. It can be performed within short intervention times and low radiation exposure for differentiation of unclear lesions.

Introduction

Pancreatic cancer is one of the most deadly malignancies worldwide. Despite being responsible for only 3% of all new cancer diagnoses yearly, it is the fourth most common cause of death from cancer.[1–3] At time of initial diagnosis, 80–90% of patients show unresectable disease or metastases.[4] The median survival at time of diagnosis of metastatic pancreatic cancer is 4.6 months.[3] Due to the high aggressiveness of pancreatic cancer, an early diagnosis is crucial to reduce its mortality. For this reason, pancreatic lesions that are suggestive of malignancy should be investigated carefully to obtain a reliable diagnosis.

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Currently, blood tests and diagnostic imaging techniques, such as ultrasound (US), magnetic resonance imaging (MRI), or computed tomography (CT), are considered standard methods for diagnosis of pancreatic cancer. Although most cases of pancreatic cancer are easy to diagnose with imaging, treatment decisions have to be made based on histopathological diagnosis.[5] Hence, tissue diagnosis is obligatory before starting chemotherapy.

Nowadays, image-guided interventions are safe techniques in the management of cancer patients. Biopsies of pancreatic tumours including fine-needle aspiration (FNA) and percutaneous core-needle biopsy are commonly performed using US (endoscopic US-guided fine-needle aspiration biopsy [EUS-FNA]) or CT guidance.

The aim of the present study was to evaluate the safety, efficacy, radiation dose, duration, diagnostic yield, and intervention-related complications of CT-guided percutaneous biopsies of pancreatic lesions suspicious for malignancy in a clinical context.

Materials and methods

Patient population

This single-centre retrospective analysis investigated 48 patients (18 female, 30 male) with CT-guided percutaneous biopsy of suspicious pancreatic lesions between August 2015 and January 2018. CT-guided interventions were performed by four radiologists with each more than 5-years of experience in CT-guided procedures.

At the time of intervention, the mean age was 64.2 years (range: 29–84 years). No patient had a medical history of pancreatic disease. The institutional review board approved the research protocol of this retrospective monocentric study and waived the need for informed patient consent. All procedures were carried out in accordance with the Declaration of Helsinki.

Inclusion and exclusion criteria

All patients were evaluated in the multidisciplinary gastroenterological meeting and selected for CT-guided biopsy of a suspicious pancreatic lesion. CT guidance was indicated for pancreatic lesions not accessible by US or with negative histopathological findings in US-guided biopsy or EUS-FNA. The coagulation profile was examined prior to intervention and did not extend the following values: International normalised ratio (INR) <1.5, a partial thromboplastin time (PTT) >40 seconds, and platelet count $<50{,}000/\mu l$. Patients with unclear pancreatic lesions accessible by US or endoscopic US, as well as known history of malignant disease were excluded.

CT-guided intervention

CT-guided interventions were performed using a 64-section CT system (Somatom Definition AS, Siemens Healthcare, Erlangen, Germany). An unenhanced CT examination for planning was performed prior to the intervention. If the lesion was not visible in this image series, an additional contrast-enhanced CT examination with arterial and venous phases was performed. This dataset was transferred to a three-dimensional (3D) planning workstation (SyngoVia, Siemens, Erlangen, Germany) to plan the needle introduction path (Fig 1).

Thereafter, the CT table was moved to the planned access position, which was projected by a navigation laser to mark the skin entry point. After sterile draping, local anaesthesia followed by a small skin incision at the needle entry point was performed. Using a single image section, the needle tip position was checked. A coaxial approach (17 G, Puncture Sheath, Somatex® Medical Technologies, Germany) in combination with a biopsy-handy (18 G, Biopsy Handy, Somatex® Medical Technologies, Germany) was used for all biopsies. The core needle was removed after adequate specimens for histopathological analysis were taken. All lesions were histopathologically verified after CT-guided biopsy by the local pathology department. Upon completing the entire procedure, single CT images of the target region including all adjacent structures were acquired to rule out immediate complications.

Data evaluation

All datasets were evaluated retrospectively. Clinical data and procedural details were retrieved from medical records. In addition, the database and all patient files were reviewed. Data were reported at event occurrences. All image analyses were performed by two radiologists with more than 5 and 7 years of experience in abdominal imaging und interventional radiology.

Clinical outcome

Outcome criteria included technical success as well as major and minor complications according to the Society of Interventional Radiology (SIR) guidelines.[6] CT-guided intervention was considered technically successful if the region of interest was reached and specimen taken.[6,7] Major complications were defined as any undesirable events resulting from the intervention. Complications that required no further management except appropriate monitoring according to SIR guidelines were considered as minor.

Radiological outcome

CT-guided interventions were compared with respect to the following parameters: radiation dose, duration of the procedure, number of needle correction scans and skin-to-lesion length. Dose–length products (DLP) of the complete procedure including planning CT and intervention scans were retrieved from patient protocols. To compare the exposure to radiation, the number of images taken during each intervention was recorded. The duration of the procedure was defined as the beginning to the end of the intervention, and was assessed using the planning scan as the beginning, and the last image set acquired to rule out complications as end.

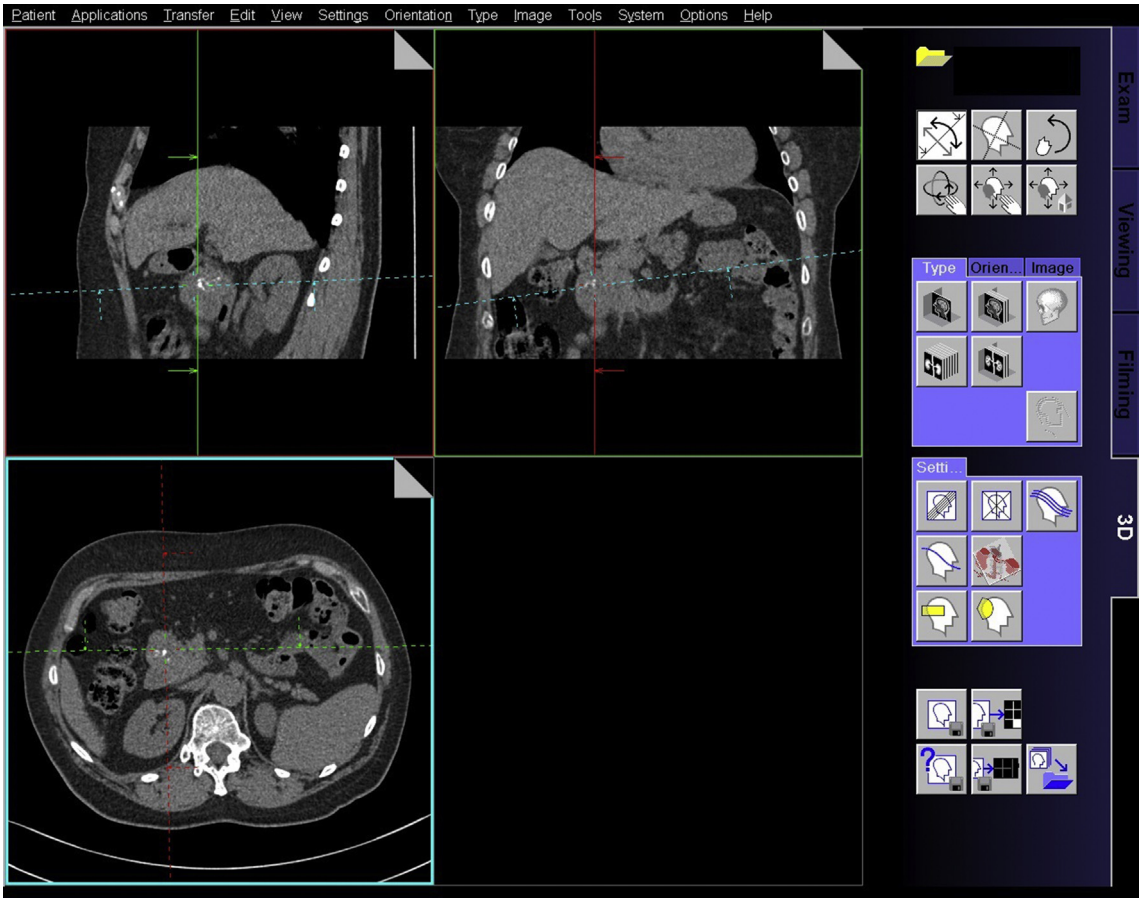

Figure 1 3D planning dataset of patient with pancreatic lesion to plan the needle introduction path.

Statistical analyses were performed using SPSS V24.0 (IBM, Armonk, NY, USA). Statistical significance was calculated using the Mann–Whitney U-test. $p<0.05$ was considered statistically significant.

Results

All CT-guided interventions ($n=48$) were performed without any serious side effects. The location of the lesions was as follows: 35.4% ($n=17$) in the pancreatic head, 41.6% ($n=20$) in the body, and 23% ($n=11$) in the tail. After US-guided biopsy including EUS-FNA with negative histopathological findings ($n=17$) or difficult access path ($n=31$), CT-guided biopsy was indicated. In 54.2% ($n=26$), a contrast-enhanced CT examination was required to delineate a focal pancreatic lesion.

The mean size of the target lesions was 2.9 cm (range: 0.7–2.3 cm). Regarding needle access, the anterior position was used in 91.6% (Figs 2 and 3), anterior trans-gastral (Fig 4a) in 2.1%, lateral in 4.2% (Fig 4b), and dorsal in 2.1% (Fig 4c). In 97.9% of cases, no other organs were traversed during biopsy of suspicious pancreatic lesions. In 2.1% of cases, the biopsy needed to be performed trans-visceral. Mean target access path within the patient was 8 cm (range: 3–14 cm). No statistical differences in overall biopsy success were demonstrated between biopsies of the pancreatic head, body and tail ($p=0.86$).

Mean duration of the intervention was 12 minutes (range: 3 minutes 30 seconds to 30 minutes). Mean skin-to-target time was 3 minutes 12 seconds, and target achieved-to-intervention end was 4 minutes 23 seconds. No significant time differences were seen comparing biopsies of the head, body, and tail of the pancreas ($p=0.16$). The mean DLP of the intervention, including all required CT examinations, was 89.5 mGy·cm (range: 12–350 mGy·cm). No significant differences in DLP were shown comparing the three groups ($p=0.58$). The average number of images needed for placement of the needle tip was 31.1 scans (range: 6–36).

Clinical outcome

In 100% ($n=48$), the CT-guided biopsy was successful. The median number of cores per patient was 3 (range: 1–3). Histopathological results showed malignant lesions of the pancreas in 37 patients (77%; Fig 1). Among this group, 66.7% ($n=32$) were adenocarcinomas (Fig 2). One patient had metastasis of non-small-cellular lung cancer (NSCLC; 2.7%), whereas another patient had lymphoma (2.7%). Three patients suffered from a neuroendocrine tumour (8.1%). Benign inflammatory lesions, including chronic pancreatitis, were found in nine cases (90.9%) and autoimmune

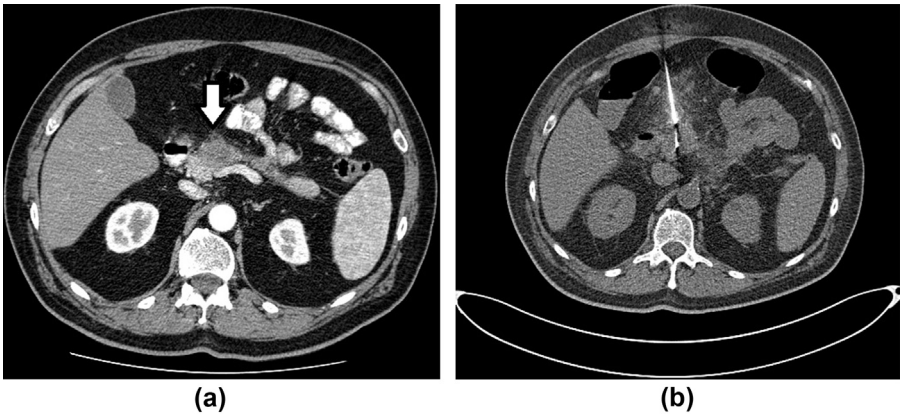

Figure 2 A 52-year-old patient with unclear focal mass located in the pancreatic head and body. (a) The size of the masses was 15×26 mm. (b) Because of better accessibility and controllability, the intervention was performed using CT-guidance. A CT image documented the location of the tip of the biopsy needle in the suspect pancreatic mass. Focal haemorrhage occurred as a minor complication. Biopsy revealed an invasive low-grade ductal adenocarcinoma.

pancreatitis in one biopsy (9.1%), were found in 11 patients (23%). Detailed results are displayed in Table 1.

During the time interval of 24 hours between biopsy and hospital discharge, no major complications occurred. With regard to minor complications, in 29.2% (n=14) a focal haemorrhage was observed directly during intervention. In all cases, no further surgical treatment or intervention was necessary. If minor complications occurred, patients were monitored according to SIR guidelines.

Discussion

Percutaneous biopsy using image-guided techniques such as US, MRI, and CT are well-established and safe techniques in the management of cancer patients.[8] Over the last 40 years, CT has developed into a well-accepted and widely used guiding tool for a broad range of percutaneous interventions, especially if guidance is not feasible using US or MRI.[8,9]

Target lesions in several structures, even in complex anatomical situations, can be accessed easily and successfully by CT guidance. CT guidance is indicated for morphologically suspicious pancreatic lesions with an inconspicuous histopathological finding after US-guided biopsy or EUS-FNA. Another indication for CT-guidance is inaccessibility by endoscopic or percutaneous US. With the use of various reconstructions in different angulations with a minimal expenditure of time, CT guidance enables exact needle positioning. The accuracy of the puncture, duration of intervention, and complication rates depend on target size and site, traversing and surrounding anatomical structures, the material and puncture technique selected, as well as patient cooperation.[8,10] Altogether, the result provides higher diagnostic accuracy with fewer complications.[10,11] The main disadvantage of CT guidance is the radiation exposure to both the patient and the interventionist. Therefore, planning and control scans during the intervention should be limited to the minimum quantity. Dose settings should be chosen carefully to achieve sufficient image quality needed to identify the target lesion and important anatomical structures clearly with maximum dose reduction. The number of sequential scans should be kept as low as possible.[10]

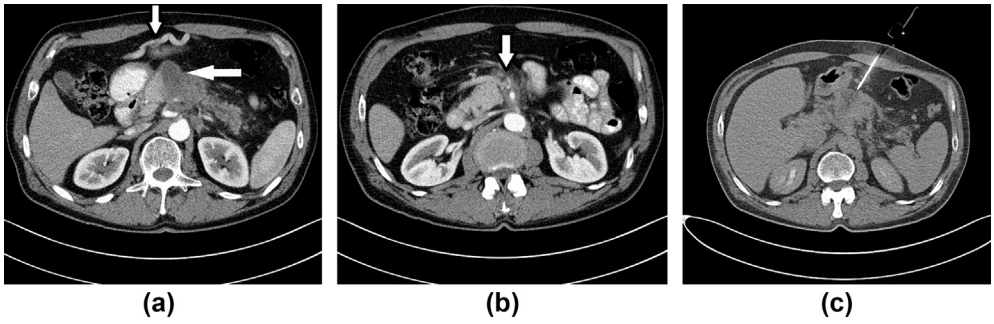

Figure 3 A 46-year-old woman with a malignant-typical lesion in the pancreatic body and inoperability of the tumour due to CT findings. The pancreatic tumour mass was inaccessible by endoscopic and percutaneous US. The histopathology report revealed an invasive ductal adenocarcinoma. The CT-guided intervention was performed without any complications. (a) Contrast-enhanced axial planning CT shows a malignant tumour mass (arrow) in the pancreatic body. The perfused umbilical vein impeded a direct puncture of the pancreatic tumour. (b) Contrast-enhanced CT shows vascular tumour invasion of the superior mesenteric artery. (c) CT-image documented the correct placement of the biopsy needle tip in the pancreatic tumour, using a lateral access route. The umbilical vein is located medial to the biopsy needle.

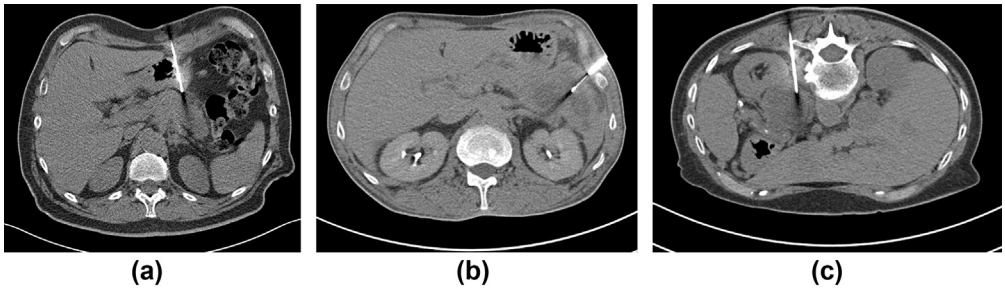

Figure 4 CT image documented the biopsy needle pathway to the pancreatic tumour, using anterior trans-gastral (a), lateral (b) and dorsal (c) guidance route.

Due to the complex anatomical location of the pancreas, biopsies of pancreatic lesions are primarily performed using fine-needle aspiration and EUS-FNA.[12] MRI-guided interventions are a much more complex and time-consuming. Usually, MRI guidance is utilised for interventional procedures in very tricky anatomical regions when high soft-tissue contrast is necessary, for example, in the breast or prostate.[10]

In the present study, the CT-guided intervention was successful in all cases. With regard to minor complications, in 29.2% a focal haemorrhage was observed directly during intervention, with no further treatment necessary. In comparison to Strobl *et al.*, there was a 94.2% success rate for biopsies of the pancreas. Nevertheless, with a success rate of 100% in the present study, the procedure is accurate and safe.[13] No major complications occurred in the present study. In a few cases, minor complications were observed directly during the intervention. Li *et al.* reported that 19 minor (18.2%) and three major (2.9%) complications occurred during the intra- or 30-day post-interventional period.[14] Hence, in comparison with the present results, the complication rate of the study cohort of Lie *et al.* is higher. Furthermore, the radiation dose of CT fluoroscopy-guided biopsy is increased in comparison with the single-shot technique.

Table 1
Patients characteristics and results of pancreatic biopsies.

Characteristic	No. of patients (%)
Mean age (range), years	64.2 (29–81)
Sex	
Male	30 (62.5%)
Female	18 (37.5%)
Location of lesion	
Head	17 (35.4%)
Body	20 (41.6%)
Tail	11 (23%)
Mean size (range), cm	2.9 (0.7–2.3 cm)
Access path	
Anterior position	44 (91.6%)
Anterior trans-gastral	1 (2.1%)
Lateral	2 (4.2%)
Dorsal	1 (2.1%)
Mean target access path (range), cm	8.0 (3–14)
Mean duration of intervention (range)	12 min (3 min 30 s to 30 min)
Mean dose–length product (range), mGy·cm	89.5 (12–350)
Images need for correct needle placement (range)	31.1 (6–36)
Success of biopsy	
Yes	48 (0%)
No	0
Results of biopsy	
Malignant	37 (77%)
Adenocarcinoma	32 (86.5%)
NSCLC metastasis	1 (2.7%)
Lymphoma	1 (2.7%)
Neuroendocrine tumour	3 (8.1%)
Benign inflammatory lesions	11 (23%)
Chronic pancreatitis	10 (90.9%)
Autoimmune pancreatitis	1 (9.1%)

NSCLC, non-small cell lung cancer.

Concerning the anatomical localisation, biopsies of the pancreas are often challenging. The access pathways comprise, for example, the trans-gastral, trans-intestinal, and trans-hepatic approaches using the anterior route. In some patients, a lateral or posterior route is necessary.[13,15] Various access pathways were used in the present study, including the anterior path, anterior trans-gastral, lateral, and dorsal.

In the study of Hsu *et al.*, trans-organ biopsies of pancreatic masses were performed safely via a direct pathway traversing the stomach, colon, small bowel, liver, and spleen.[16] There were no statistically significant differences in complication rates among the different biopsy routes, trans-mesenteric and retroperitoneal versus trans-organ approaches.[16] In the present study, biopsies traversing the colon and spleen were avoided due to the possibility of side effects, especially abdominal infection and bleeding.

This study has several limitations worth mentioning. The study design is retrospective and does not include a randomised protocol with a control group. Due to the retrospective nature of the study, the overall duration of the intervention is higher. Pre- and post-interventional times are absent. Further, the study population is limited. To validate the present results, a larger cohort should be evaluated and a prospective design should be used.

CT guidance is indicated for unclear or suspicious pancreatic lesions after unsuccessful US-guided biopsy including EUS-FNA in the pancreatic head or negative histopathological findings, as well as for lesions inaccessible by an US-guided approach. CT-assisted pancreatic biopsy

should optionally be provided as a first-line biopsy method, so that diagnostic periods can be shortened and treatment with chemotherapy can be started faster.

In conclusion, CT-guided biopsies of the pancreas are a safe and efficient method and can be performed with short intervention times, low radiation exposure, and a huge benefit for the patient leading to optimal clinical results in diagnosis and treatment of pancreatic cancer.

Conflict of interest

T.G.-R. received travel grants and research founding from PharmaCept and Guerbet. M.C.L. received travel grants or research founding from PharmaCept and Guerbet. T.V. received travel grants or research founding from PharmaCept, MedTronic, Siemens and Guerbet. The other authors declare no Conflicts of Interests.

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