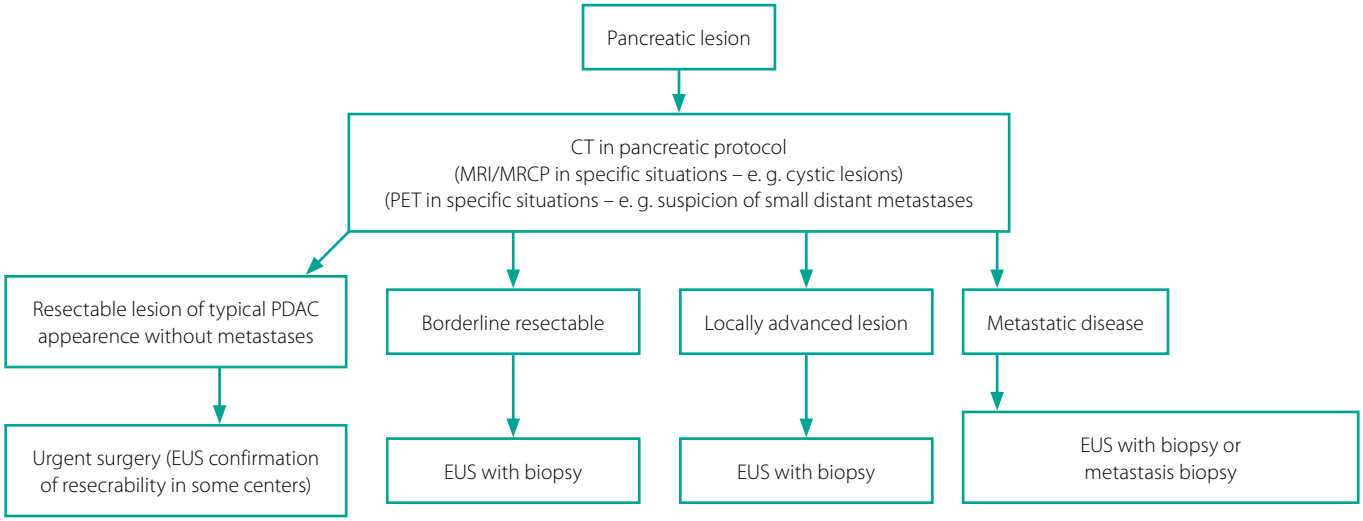
Fig. 2. *Diagnostic work-up of a suspected pancreatic tumor (according to Ducreux et al. and Lang et al. (37, 38)).*



CT – computed tomography; MRI – magnetic resonance imaging; MRCP – magnetic resonance cholangiopancreatography; PET – positron emission tomography; PDAC – pancreatic ductal adenocarcinoma; EUS – endoscopic ultrasound.

ring disease response to systemic treatment in the neoadjuvant or metastatic setting (50–53). Elevated preoperative CA 19-9 may also help identify patients whose surgeries are less likely to result in an R0 (margin-negative) resection and can predict long-term survival after resection (19, 39, 54).

Carcinoembryonic antigen (CEA) and CA 125 are nonspecific markers that might be elevated in patients with PDAC as well. According to reports in the literature, the combination of serum CA 19-9 with CA 125 increased sensitivity, and the combination of CA 19-9 with CEA increased specificity compared to CA 19-9 alone (55, 56).

In recent years, novel blood-based biomarkers for early diagnosis and prognostic stratification have made progress. Studies have confirmed that abnormally expressed serum non-coding microRNAs (miRNAs) have certain significance in the diagnosis of early-stage PDAC, or even in precancerous pancreatic lesions (44, 57). The diagnostic value of microRNAs was shown to be higher than that of conventional serum markers (58), and there is evidence that the combination of miRNAs and CA 19-9 is more accurate (59, 60). Moreover, miRNA expression profiles may distinguish between malignant and benign lesions of the pancreas (61), and they may be used for the prediction of chemoresistance and facilitate personalized treatment planning (44, 62). Another emerging strategy are so-called "liquid biopsies" that can capture tumor-associated components, such as circulating tumor DNA, extracellular vesicles, and circulating tumor cells. It has been reported that circulating tumor cells can be detected in the peripheral blood of 40%–100% of pancreatic cancer patients, which may be used for the diagnosis of early PDAC (63). These novel methods seem very promising, although further studies are needed to verify the results and validity of these strategies in clinical practice.

Imaging methods

Abdominal ultrasound (US) is a non-invasive, broadly available, and easily feasible technique that is usually the first imaging method used in suspected pathology of the pancreatobiliary tract (64). The disadvantage of abdominal US is its low specificity, expert dependence, and also the dependence on the patient's body habitus (64). According to various authors, the sensitivity of US in PDAC detection ranges from 48%–98% (64, 65). In a Japanese multicenter study involving early-stage pancreatic cancers, dilatation of the MPD was the most common abnormality on US in up to 75% patients (66).

Computed tomography (CT) has a crucial role in diagnosis, staging, and planning or monitoring the treatment of patients with PDAC (64, 67). Currently, a biphasic pancreatic protocol with submillimeter section thickness and standard use of multiplanar reconstructions are recommended (64, 67). It involves both intravenous contrast with a high iodine content (at a rate of 3–5 ml/s) and ingestion of water as a neutral oral contrast (64). The pancreatic phase should be performed after 40–50 seconds and the portal phase after 65–70 seconds following intravenous contrast application. Three-dimensional (3D) images are convenient for assessing tumor-vessel relationships, especially before planned surgery (64).

Based on the extent of disease, PDAC is divided into one of four categories: resectable (Fig. 3), borderline resectable, locally advanced (Fig. 4), and metastatic (Fig. 5). Due to the gradual improvement of CT imaging technology, the sensitivity of CT for detection and evaluation of PDAC resectability has increased from 76% to 95% and 73% to 83%, respectively (67). CT is accurate for determination of unresectable disease with sensitivity of up to 91% and specificity of 100% (64).

To assess resectability of the lesion, it is necessary to assess potential infiltration of the superior mesenteric artery, coeliac axis and its branches, portal vein, and superior mesenteric vein. Three degrees of vascular contact with the tumor are evaluated, i.e., no contact, abutment (≤180°), or encasement (>180°), on the basis of which it is possible to predict resectability (64, 68). The disadvantage of CT in determining local resectability of PDAC is the existence of interobserver variability among evaluators, even among experienced radiologists (69). In additi-