Reinterpretation of radiological imaging in patients referred to a tertiary referral center with a suspected pancreatic or hepatobiliary malignancy; impact on treatment strategy

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Abstract

Objective. To determine the clinical importance of reinterpretation of radiological investigations performed in a referring hospital and the value of additional investigations in a referral center.

Patients and methods. A panel of four experts retrospectively evaluated the technical quality of radiological investigations and made reinterpretation reports, of 78 patients referred with a suspected pancreatic or hepatobiliary malignancy. The value of additional radiological investigations performed in the referral center was assessed.

Results. The quality of ultrasound and CT examinations was sufficient for reinterpretation in (36/69) 52% and (42/60) 70% respectively. The reinterpretation reports of the ultrasound investigations were scored as ‘in accordance’ in (30/36) 83%, as ‘minor discordance’ in (3/36) 8% and as ‘major discordance’ in (3/36) 8%. For CT proportions of (29/42) 69%, (8/42) 19% and (5/42) 12%, respectively were found.

Additional ultrasound (n=55) showed no additional findings in 16%, minor additional findings in 53% and major additional findings in 31%. For additional spiral CT scan (n=47) results were of 21%, 47% and 32% respectively.

Conclusion. Reinterpretation of ultrasound and CT resulted in a change in treatment strategy for 7 patients (9%). Additional ultrasound or CT resulted in a change in treatment strategy for 24 patients (30%). Improved communication and reinterpretation of radiological investigations may reduce unnecessary referral.
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Introduction

The only chance of cure for patients with a pancreatic or hepatobiliary malignancy is resection of the tumor. Because of the complexity of tumor staging and resection, many patients with a suspected pancreatic or hepatobiliary malignancy are referred to a tertiary care referral center for further diagnostic investigations and subsequent treatment or for a second opinion at the patient's request.1,2 These patients are generally referred after radiological workup elsewhere. Diagnostic possibilities and accuracy differ between referring hospitals, according to the local circumstances concerning available equipment and expertise. Occasionally, marked differences in the interpretations were noted when radiological studies performed elsewhere of patients referred to our hospital were reviewed. Discordance between the initial and the new interpretations of these earlier investigations have resulted in a change in tumor stage, with often important therapeutic consequences for the patient. Some patients referred for resection of a pancreatic or hepatobiliary tumor were judged unresectable at reinterpretation of the radiological images made in the referring hospital.

The aim of the study was to determine the clinical importance of reinterpretation of the radiological investigations performed in a referring hospital as well as the accuracy of the diagnosis at referral. Moreover, the aim was to determine the technical quality of the radiological investigations and the completeness of the radiological reports from referring hospitals, as well as the value of additional investigations in a referral center.

Patients and Methods

Patients referred to the Academic Medical Center, (AMC) Amsterdam, The Netherlands, for diagnostic workup, treatment or a second opinion of a suspected pancreatic or hepatobiliary malignancy are discussed in a multidisciplinary meeting in which gastroenterologists, hepatologists, hepatobiliary surgeons and abdominal radiologists gather twice weekly.

Seventy-eight patients with a suspected pancreatic or hepatobiliary malignancy who were discussed between January 1999 and January 2000 were included in this study. The 41 male and 37 female patients with a mean age of 59 years (range 29-80) were referred from 51 hospitals throughout the Netherlands. The radiological images from the referring hospitals were retrieved, together with the radiological reports and the letters at referral. Seventy-two patients (92%) were referred for additional diagnostic workup and/or treatment, while 6 (8%) were referred for a second opinion at the patient's request. The final diagnoses were: a periampullary carcinoma in 32 patients (40%), a hilar cholangiocarcinoma in 18 patients (23%), a gall bladder carcinoma in 6
patients (8%), a pancreatic body/tail carcinoma in 3 patients (4%), a primary or secondary liver tumor in 2 patients (3%) and a focal pancreatitis in 16 patients (21%).

A panel consisting of two experienced abdominal radiologists, one hepatobiliary surgeon and one gastroenterologist was assembled for this study. The panel evaluated and interpreted, in a consensus reading the radiological investigations (ultrasound examination and CT scans) from the referring hospitals in a separate session. The members of the panel were blinded from the content of the initial radiological report, the letter at referral and the final diagnosis, but were aware of the clinical symptoms of the patient at the time of the investigation.

The ultrasound examinations and CT scans were reviewed in order to assess the image quality and the completeness of the visualization of the organs of interest. Other investigations like Endoscopic Retrograde Cholangiopancreatography (ERCP) and Magnetic Resonance Imaging (MRI) were not studied, due to the mainly therapeutic purpose and the relative small number of examinations respectively.

The quality of the investigations was rated as ‘sufficient for reinterpretation’ or ‘not sufficient for reinterpretation’. The ultrasound examinations had to comply with the following criteria to be considered as ‘sufficient for reinterpretation’: 1) complete visualization of organs of interest and 2) if a tumor was seen localization, size and relation with adjacent structures should be visible. The CT scans had to comply with the following criteria to be considered as ‘sufficient for reinterpretation’: 1) slice thickness: 8mm or less; 2) intravenous contrast administration resulting in enhancement of the portal venous system, the liver and pancreatic parenchyma and 3) absence of artifacts degrading image quality. When the quality of the ultrasound examination or CT scan was found to be ‘not sufficient for reinterpretation’, the reinterpretation was not performed.

A reinterpretation report of the radiological investigations obtained from the referring hospital was written down on standardized forms.

The reinterpretation reports were compared with the initial reports and were scored as ‘accordant’ or as ‘minor discordance’ or of ‘major discordance’. A ‘minor discordance’ was defined as without therapeutical consequences (meaning a possible change in therapy) for the patients. For example: when ingrowth from a periampullary tumor into the duodenum was missed during the first interpretation of the investigations and was seen after reinterpretation, it would not change the treatment strategy, since the duodenum would be resected during a (pylorus preserving) pancreaticoduodenectomy. A ‘major discordance’ was defined as resulting in therapeutical consequences. For example: The presence of a liver metastases in a patient with pancreatic cancer found during reinterpretation of the investigations would change the treatment strategy from exploratory laparotomy into non-surgical palliation.
All diagnoses were verified with the best available gold standard. The gold standard in decreasing order of validity was: pathology of resected specimen, histological or cytological percutaneous biopsy, findings at surgery, dedicated pancreatic and liver CT scan confirmed with clinical follow-up and survival data. The diagnosis at referral was compared with the final diagnosis.

The content of the radiological reports of ultrasound examinations and CT scans was reviewed in order to evaluate the completeness, according to a list of features made by the reinterpretation panel, which should at least be described in the radiological report (presence or absence of a tumor, its localization and extent, ingrowth into adjacent structures and presence of enlarged lymph nodes or metastases).

In the referral center, additional radiological investigations were performed in order to stage the tumor. The additional ultrasound examinations were performed by an abdominal radiologist performing Doppler studies of the portal venous system and the hepatic artery. The additional CT scans were performed using the following protocol: pancreatic and portal phase spiral scan, 3.2mm slice thickness, 130 ml intravenous contrast, 3ml/sec injection rate and 55s scan delay. The additional value of the radiological examinations performed in the AMC was rated as 'not present' if already known results were confirmed, as 'present, without a change in treatment' if new viewpoints did not result in a change in treatment strategy and as 'present, with change in treatment' if new viewpoints resulted in a change in treatment strategy. Statistical analysis was performed using the SPSS 9.0 statistical package.

Results

The diagnosis at referral was the same as the final diagnosis in 40 of the 78 patients (51%). An incorrect diagnosis at referral was present in 11 of the 78 patients (14%). The final diagnosis was pathology proven in 50 of the 78 (64%) and was based on pancreatic and liver CT scan confirmed with clinical follow up in 28 of the 78 (36%). Nineteen of these patients were considered to have unresectable tumors, none of them did survive 24 months after referral, their median survival was 9 months (range 3-22 months) which is in accordance with the life expectancy with regard to the different tumor types. Nine patients were considered to have a focal pancreatitis, two of them died, one due to a cardiovascular disease, the other due to esophageal cancer, the other seven patients are alive, five with signs of pancreatitis.

Ultrasound examination

Transabdominal ultrasound examination of the abdomen was performed in 74 patients in the referring hospital (Table 1). Of five patients no hard copies to document
the examination were available, so 69 examinations could be considered for reinterpretation. In 33 cases (48%), the quality of the ultrasound was 'not sufficient for reinterpretation'. Of the remaining 36 examinations a reinterpretation was made. The cases in which a 'major discordance' occurred were the following: in one patient a tumor in the pancreatic tail was missed, in another patient the tumor was localized in the gall bladder instead of in the pancreatic head as was presumed and in the third patient tumor ingrowth of a pancreatic head tumor into the duodenum and the portal vessels was missed.

Table 1 Results of evaluation of ultrasound examinations performed before referral

<table>
<thead>
<tr>
<th>Ultrasound Reviewed</th>
<th>Quality</th>
<th>n=74</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>'Not sufficient for reinterpretation'</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>'Sufficient for reinterpretation'</td>
<td>36</td>
</tr>
<tr>
<td>Conclusion of reinterpretation</td>
<td>Accordant</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Minor discordance</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Major discordance</td>
<td>3</td>
</tr>
</tbody>
</table>

If the ultrasound examination was 'sufficient for reinterpretation', a reinterpretation report was made

CT scan

A CT scan was performed in 60 patients in the referring hospital and all examinations were available for reinterpretation (Table 2). In 18 cases (30%) the quality of the CT scan was 'not sufficient for reinterpretation'. Of the remaining 42 CT scans, a reinterpretation report was made. In 8 cases (19%) a minor discordance was found; in 5 cases (12%) a major discordance was found. The 5 cases in which “major discordance” occurred were the following: the tumor was not identified in 3 patients (1 gall bladder, 1 papilla, 1 pancreatic head), in one patient a proximal bile duct tumor turned out to be a gall bladder carcinoma, and in another patient extensive portal venous ingrowth precluding resection was missed.

Seventy-seven of the 78 reinterpretations of ultrasound examination or CT scan, which were made by the panel, turned out to be concordant with the final diagnosis. One reinterpretation of a CT scan resulted in the suggestion of a pancreatic head
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tumor, which finally turned out to be a focal chronic pancreatitis. So there was one false positive finding after reinterpretation.

**Table 2** Results of evaluation of CT scans performed before referral

<table>
<thead>
<tr>
<th>CT Reviewed</th>
<th>n= 60</th>
<th>Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘Not sufficient for reinterpretation’</td>
<td>18 (30%)</td>
<td></td>
</tr>
<tr>
<td>‘Sufficient for reinterpretation’</td>
<td>42 (70%)</td>
<td></td>
</tr>
</tbody>
</table>

**Conclusions of reinterpretation**

- Accordant | 29 (69%) |
- Minor discordance | 8 (19%) |
- Major discordance | 5 (12%) |

*If the CT scan was ‘sufficient for reinterpretation’, a reinterpretation report was made*

**Completeness of radiological reports**

The completeness of the radiological reports was evaluated according to the description of the absence or presence of a tumor, enlarged lymph nodes and metastases in the reports from ultrasound examinations and CT scans (Table 3).

**Table 3** Content of radiological report; description of features in the radiological report needed for tumor staging

<table>
<thead>
<tr>
<th>Description of presence or absence of</th>
<th>Ultrasound</th>
<th>CT</th>
</tr>
</thead>
<tbody>
<tr>
<td>tumor</td>
<td>n=67</td>
<td>n=50</td>
</tr>
<tr>
<td>liver metastasis</td>
<td>65 (95%)</td>
<td>49 (98%)</td>
</tr>
<tr>
<td>enlarged lymph nodes</td>
<td>27 (40%)</td>
<td>32 (64%)</td>
</tr>
<tr>
<td>enlarged lymph nodes</td>
<td>9 (13%)</td>
<td>23 (4%)</td>
</tr>
</tbody>
</table>

*Additional investigation in the referral center*

After referral to the AMC, an additional ultrasound examination in combination with Doppler studies was performed in 55 patients (71%) (Table 4). These
examinations confirmed the conclusions of the referring hospital in 9 patients (16%), revealed additional information without a change in treatment strategy in 29 patients (53%) and revealed additional information with a change in treatment strategy in 17 patients (31%). An additional CT scan was performed in the AMC in 47 patients (60%). These scans confirmed the conclusions of the referring hospital in 10 patients (21%), revealed extra information without change in treatment strategy in 22 patients (47%) and revealed extra information with a change in treatment strategy in 15 patients (32%).

The median period of time between the initial investigation performed in the referring hospital and the first examination in the AMC was 24 days.

Table 4 Additional diagnostic value of extra ultrasound examinations and CT scans performed in the referral center

<table>
<thead>
<tr>
<th>Additional value</th>
<th>Ultrasound n=55</th>
<th>CT n=47</th>
</tr>
</thead>
<tbody>
<tr>
<td>not present</td>
<td>9 (16%)</td>
<td>10 (21%)</td>
</tr>
<tr>
<td>present, without a change in treatment</td>
<td>29 (53%)</td>
<td>22 (47%)</td>
</tr>
<tr>
<td>present, with a change in treatment</td>
<td>17 (31%)</td>
<td>15 (32%)</td>
</tr>
</tbody>
</table>

Discussion

The value of reinterpretation of radiological investigations of patients with a suspected pancreatic or hepatobiliary malignancy, who are referred to a specialized center, is considerable, as shown in this study. Discrepancies in interpretation of the same images between radiologists from the referring hospital and the reinterpretation panel are shown.

In 24% (19/78) of the investigations (36 ultrasound examinations and 42 CT scans 'sufficient for reinterpretation'), additional information was revealed; in 14% 'minor discordance' and in 10% 'major discordance' were found, with an actual change in treatment strategy in 7 patients. Earlier studies showed similar results: major discordance was found in 13-30% after reinterpretation of CT scans⁴,⁵ and in 23-42% after reinterpretation of MRI.⁶,⁷ These relatively large differences can be due to differences in the patient population and selection criteria. The population in this study might have been changed as 30-50% of the investigations could not be reinterpreted due to limitations on the quality and therefore were excluded from further analyses. If
these investigations would have been of better quality one could suggest reinterpretation might have shown even more effect.

Performing reinterpretations has shown to increase sensitivity and to decrease errors in a variety of radiological examinations.\textsuperscript{8-9, 10} Errors in the interpretation of radiographic studies can be due to perceptual misses such as unfamiliarity with a specific disease, its pattern of spread and staging criteria or lack of a state-of-the-art-scanning-technique. The lack of sufficient clinical information about the patient may also play a role. During reinterpretation, the members of the panel in this study were aware of the same clinical information as the radiologist in the referring hospital had at the time of performing the investigation but the members of the panel were aware that all patients were suspected to have pancreatic or hepatobiliary disease. Furthermore the reading was done in consensus, to try and mimic the normal approach of discussing these patients in a multidisciplinary meeting in our hospital. We do realize that this might not be the situation in all the referring hospitals but we consider it the most optimal approach in a referral center. Moreover consensus reading precludes a Kappa analysis, to analyze the variance between the members of the panel, as previously substantial variation has been described in interpretation of radiological investigations.\textsuperscript{11, 12}

Although fourteen percent of the 78 patients were referred with an incorrect diagnosis in the letter of referral, it is difficult to draw conclusions from these findings because the intention of the referral could have been quite different. Some specialists only refer patients who were considered to have a resectable tumor after extensive workup and staging, whereas others refer patients with a diagnostic dilemma.

It is remarkable that only a few reports of radiological examinations from referring hospitals contained all the information needed to stage a tumor as suggested by the reinterpretation panel to be at least described in the radiological report. This might partially be due to the fact that these reports were often made in an early stage of the diagnostic process, initially on a patient with unidentified abdominal symptoms without the clinical suspicion of pancreatic or hepatobiliary disease. An issue might be that there are no guidelines in the Dutch radiological society for the minimal content of a radiological report of ultrasound examination and CT scan of patients with the suspected of a malignant pancreatic or hepatobiliary tumor. Similar problems have been addressed for multiple myeloma\textsuperscript{13} and lung cancer.\textsuperscript{14, 15} Development of standards or guidelines in order to make radiological reports more uniform and complete will improve the quality of these reports, will facilitate transfer of patients between physicians and as a result will be of advantage for the patient. A complete radiological report could lead to definitive tumor staging earlier in the diagnostic process, which could lead to fewer unnecessary investigations and a reduction of the ‘patient passage time’, thereby reducing the costs. It also could limit referral of
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patients with an incurable disease being referred with the prospect of undergoing a curative resection.

The quality of ultrasound examinations as well as CT scans was scored “not sufficient for reinterpretation” in a relatively large number of the investigations. One explanation for this finding is the fact that it is difficult to assess a dynamic investigation such as ultrasound examination by means of reading hard copy images. One other reason could be the limited experience of the radiologist in the referring hospitals with the relatively rare pancreatic or hepatobiliary malignancies, together with the lack of available protocols tailored to this specific disease.

The ultrasound examinations and CT scans performed in the referral center revealed additional information patients 53 and 47%, respectively and were responsible for a change in the treatment strategy in 31 and 32% of the patients respectively. Reasons for the relatively high additional value of extra investigations in the AMC are multiple: most importantly, the presence of dedicated and more experienced radiologists and scanning protocols tailored to these specific diseases together with new equipment of good quality. However, we cannot exclude that the time interval between the initial and new investigations, although limited to approximately 4 weeks, in which the disease could progress might also lead to a change in the outcome of the radiological investigation and a change in tumor stage.

Several biases might have affected the outcome of this study. Firstly, the classification of the technical quality of the ultrasound examination and CT scan are subjective. Secondly, the gold standard is not of uniform validity because pathological proof could not always be obtained. A relatively large number of patients with unresectable disease was referred back to the referring hospital for palliative care without histological proof of the diagnosis. However their follow-up data match with the diagnosis as they all died of disease related symptoms 3-22 months after referral.

In summary, among patients with a suspected pancreatic or hepatobiliary malignancy, reinterpretation of previously performed radiological investigations resulted in a change in treatment strategy in 7 patients (9%). Furthermore, the reports of the initial investigations were often incomplete. Additional ultrasound or CT examination resulted in a change in treatment strategy for 24 patients (30%). Therefore, we conclude that reinterpretation by an experienced panel potentially benefits patients with a pancreatic or hepatobiliary malignancy. The expertise of specialized radiologists, possibly facilitated by recently available telecommunication techniques, could be used to re-evaluate the (technically appropriate) CT scans performed elsewhere. This could result in fewer unnecessary referrals or patient movements especially for patients with unresectable disease requiring no further special treatment.
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References


