Computer tomography in pre-oprative staging of pancreatic cancer
Phoa, S.S.K.S.

Citation for published version (APA):

General rights
It is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), other than for strictly personal, individual use, unless the work is under an open content license (like Creative Commons).

Disclaimer/Complaints regulations
If you believe that digital publication of certain material infringes any of your rights or (privacy) interests, please let the Library know, stating your reasons. In case of a legitimate complaint, the Library will make the material inaccessible and/or remove it from the website. Please Ask the Library: http://uba.uva.nl/en/contact, or a letter to: Library of the University of Amsterdam, Secretariat, Singel 425, 1012 WP Amsterdam, The Netherlands. You will be contacted as soon as possible.
Chapter 4

Re-interpretation of radiological imaging in patients referred to a tertiary referral center, with suspected pancreatic or hepatobiliary malignancy: Impact on treatment strategy

Esther HBM Tilleman¹, Saffire SKS Phoa², Otto M van Delden², Erik AJ Rauws³, Thomas M van Gulik¹, Johan S Laméris², Dirk J Gouma¹.

Departments of Surgery¹, Radiology², and Gastroenterology³, Academic Medical Center, Amsterdam, The Netherlands.

Accepted for publication: European J of Radiology, 2003
Objective

To determine the clinical importance of re-interpretation of radiological examinations, performed in a referring hospital, and the value of additional investigations, performed in a tertiary referral center.

Patients and methods

A panel of four experts retrospectively made re-interpretation reports and evaluated the technical quality of radiological examinations, that had been performed previously, in 78 patients referred with suspected pancreatic or hepatobiliary malignancy. Accordance of the panel’s findings with the referral report and the value of additional radiological investigations, performed in the center that patients were referred to, were assessed.

Results

The quality of ultrasonographic and CT examinations was judged as sufficient for re-interpretation in 52% (36/69) and 70% (42/60), respectively. For US examinations the re-interpretation reports, compared with the original reports, were in accordance in 83% (30/36), had minor discordance in 8% (3/36), and had major discordance in 8% (3/36). For CT scans accordance was 69% (29/42), minor and major discordances were 19% (8/42) and 12% (5/42), respectively.

Additional US examinations (n=55) did not reveal additional findings in 16%. Minor additional findings were found in 53%, and major additional findings in 31%. For additionally performed spiral CT scans (n=47) results were 21%, 47%, and 32%, respectively.

Re-interpretation of US and CT examinations resulted in a change in treatment strategy in 7 patients (9%). Additionally performed US and CT examinations resulted in a change in treatment strategy in 24 patients (30%).

Conclusion

Re-interpretation of radiological investigations may reduce the number of unnecessary referrals and may limit the use of additional examinations. Compared to referral examinations, additional US and CT examinations resulted in treatment change in 30% of the referred patients.
Re-interpretation of radiological imaging

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 center, generally after radiological work-up elsewhere, for further diagnostic investigations, subsequent treatment, or for second opinion at the patients request\textsuperscript{1,2}. Between referring hospitals diagnostic possibilities differ, due to local circumstances and availability of equipment and expertise. Occasionally, marked differences in interpretations were noted when reviewing radiological studies, that had been performed elsewhere, in patients that were referred to our hospital. Discordances between the initial and the new interpretations of these prior investigations sometimes resulted in a change in tumor stage, with important therapeutic implications. Some patients, referred for resection of a pancreatic or hepatobiliary carcinoma, were judged to have an unresectable tumor at re-interpretation of prior radiological studies. The aim of this study was to determine the clinical importance of re-interpretation of radiological studies, performed in a referring hospital, and to determine the accuracy of the referral diagnosis. Furthermore, to assess the technical quality of the radiological examinations, the completeness of the radiological reports from referring hospitals, and the value of additional investigations performed in the tertiary center.

Patients and Methods

Patients with suspected pancreatic or hepatobiliary malignancy, referred to the Academic Medical Center, Amsterdam, the Netherlands, for diagnostic work-up, treatment, or for second opinion are being discussed in a multidisciplinary meeting, in which gastro-enterologists, hepatologists, hepatobiliary surgeons and abdominal radiologists are gathered twice weekly. Seventy-eight consecutive patients with a suspected pancreatic or hepatobiliary malignancy, who had been discussed between January 1999 and January 2000, were included in this study. These patients (41 male, 37 female, mean age of 59 years, range 29-80) were referred from 51 hospitals throughout the Netherlands. The radiological studies from the referring hospitals were retrieved together with the radiological reports and the referral letters.
Seventy-two patients (92%) were referred for additional diagnostic work-up and/or treatment, and 6 patients (8%) were referred for a second opinion (at the patient’s request). The final diagnoses were: periampullary carcinoma in 32 patients (40%), hilar cholangiocarcinoma in 18 (23%), gall bladder carcinoma in 6 (8%), pancreatic body or tail carcinoma in 3 (4%), primary or secondary liver tumor in 2 (3%), and focal pancreatitis in 16 patients (21%).

A panel consisting of two experienced abdominal radiologists, a hepatobiliary surgeon, and a gastroenterologist, was assembled for this study. In a consensus reading the panel evaluated and re-interpreted the radiological investigations (US examinations and CT scans) from the referring hospital. The members of the panel were blinded for the content of the initial radiological report, for the letter at referral, and for the final diagnosis, but they were aware of the clinical symptoms that the patient had at the time of the investigations.

The US examinations and CT scans were reviewed to assess image quality and completeness of visualisation of the organs of interest. Other investigations such as ERCP and MRI were not studied, because of the mainly therapeutical purpose of ERCP and the relative small number of the MRI examinations.

The quality of the investigations was rated as “sufficient” or “insufficient” for re-interpretation. The US examinations regarded as sufficient for re-interpretation complied with the following criteria: 1) complete visualisation of organs of interest, 2) if a tumor was present the localization, size, and relationship with adjacent structures needed to be visible. The CT scans had to comply with the following criteria to be considered as “sufficient” for re-interpretation: 1) slice thickness of < 8 mm, 2) intravenous contrast administration, resulting in sufficient enhancement of the portal-venous system, the liver and the pancreatic parenchyma, 3) absence of artefacts that degraded image quality. If the quality of a US or CT examination was found to be insufficient for re-interpretation, no further re-interpretations were made.

A re-interpretation report was written down on standard forms and was scored as being “accordant” or as having “minor” or “major” discordance, compared to the initial radiological report. A minor discordance was defined as one that had no therapeutical consequences (meaning no change in therapy). For example: if ingrowth from a periampullary tumor into the duodenum was missed at initial interpretation, but it was noted at re-interpretation, this would be regarded as a minor discordance. This findings would not have resulted in change of treatment strategy (a resection) as the duodenum
Re-interpretation of radiological imaging

would have been resected during a pancreatice-duodenectomy. A "major" discordance was defined as one that would have had therapeutical consequences. For example: the finding of a liver metastasis during re-interpretation, in a patient with pancreatic cancer, that would have changed the treatment strategy from exploratory laparotomy into a non-surgical palliation.

All diagnoses were verified with the best available standard. The 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 completeness of the referral radiological reports of US examinations and CT scans was assessed by the panel, according to a list made by the panel of minimally required descriptions in a radiological report (presence or absence of a tumor, its localization and extent, ingrowth into adjacent structures and presence or absence of enlarged lymph nodes or metastases).

In the referral center additional radiological investigations were performed in order to stage the tumor. Additional US examinations, performed by an abdominal radiologist, included Doppler studies of the portal venous system and of the hepatic and superior mesenteric arteries. The additional CT scans were performed using the following protocol: dual slice spiral CT scan, 3.2 mm slice thickness, 130 ml iv contrast, 3 ml/sec injection rate, delay 55 s. 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 result in a change in treatment strategy. Statistical analysis was performed using the SPSS 9.0 statistical package.

Results

The diagnosis at referral was the equal to the final diagnosis in 40 of the 78 patients (51%) and in the differential diagnosis at referral the final diagnosis was mentioned, as the first or second most likely diagnosis, in 27 of the 78 patients (35%). An incorrect
diagnosis at referral was present in 11 of the 78 patients (14%). The final diagnosis was based on findings at pathology in 50 of the 78 patients (64%), and was based on CT findings and clinical follow up in 28 of the 78 patients (36%): 19 patients were considered to have unresectable tumors (median survival was 9 months, range 3-22 months, after referral). Nine patients were considered to have a focal pancreatitis, of these two patients have died (one due to cardiovascular disease, one due to oesophageal cancer), and seven patients are alive at present (5 with signs of pancreatitis).

Ultrasound examination

Transabdominal ultrasound examination of the abdomen was performed in 74 patients in the referring hospital (Table 1). Of 5 patients no hard copies to document the examination were available, so 69 examinations could be considered for re-interpretation. In 33 cases (48%), the quality of the ultrasound was regarded as “insufficient for re-interpretation”. The remaining 36 examinations were re-interpreted. In three cases a “major discordance” occurred: in one patient a tumor in the pancreatic tail was missed, in another patient the tumor was localized in the gallbladder instead of in the pancreatic head as was presumed and in the third patient with a pancreatic head carcinoma, tumor invasion into the duodenum and the portal vessels had been missed.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Results of evaluation of US examinations, performed before referral</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
</tr>
<tr>
<td>Ultrasound</td>
<td></td>
</tr>
<tr>
<td>Reviewed</td>
<td>74</td>
</tr>
<tr>
<td>Quality</td>
<td></td>
</tr>
<tr>
<td>Not sufficient for re-interpretation</td>
<td>33</td>
</tr>
<tr>
<td>Sufficient for re-interpretation</td>
<td>36</td>
</tr>
<tr>
<td>Conclusion of re-interpretation*</td>
<td></td>
</tr>
<tr>
<td>Accordant</td>
<td>30</td>
</tr>
<tr>
<td>Minor discordance</td>
<td>3</td>
</tr>
<tr>
<td>Major discordance</td>
<td>3</td>
</tr>
</tbody>
</table>

*a re-interpretation report was made only if the US exams were sufficient for re-interpretation.

CT scan

A CT scan was performed in 60 patients in the referring hospital and all examinations were available for re-interpretation (Table 2). In 18/60 cases (30%) the quality of the CT scan was regarded as “insufficient for re-interpretation”. Of the remaining 42 CT scans a re-interpretation report was made. In 8 cases (19%) a minor discordance was
Table 2 Results of evaluation of CT scans performed before referral

<table>
<thead>
<tr>
<th>CT</th>
<th>n</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reviewed</td>
<td>60</td>
<td>(100)</td>
</tr>
<tr>
<td>Quality</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not sufficient for re-interpretation</td>
<td>18</td>
<td>(30)</td>
</tr>
<tr>
<td>Sufficient for re-interpretation</td>
<td>42</td>
<td>(70)</td>
</tr>
<tr>
<td>Conclusions of re-interpretation*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accordan t</td>
<td>29</td>
<td>(69)</td>
</tr>
<tr>
<td>Minor discordance</td>
<td>8</td>
<td>(19)</td>
</tr>
<tr>
<td>Major discordance</td>
<td>5</td>
<td>(12)</td>
</tr>
</tbody>
</table>

* a re-interpretation report was made only if CT scans were sufficient for re-interpretation.

found; in 5 cases (12%) a major discordance was found. The five cases in which "major discordance" occurred were the following: the tumor was not identified in three patients (1 gallbladderca, 1 papillary ca, 1 pancreatic head ca), in one patient a proximal bile duct tumor turned out to be a gall bladder carcinoma and in one patient extensive portal venous ingrowth, precluding a resection, was missed.

Seventy-seven of the 78 re-interpretations of US examination and CT scans, made by the panel, turned out to be concordant with the final diagnosis. One re-interpretation of a CT scan resulted in the suggestion of a pancreatic head malignancy, which finally turned out to be a focal chronic pancreatitis. So there was one false positive finding after re-interpretation.

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 US examinations and CT scans (Table 3). Description slightly more incomplete for US exams than for CT scans. Description of livermetastases in US was

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

<table>
<thead>
<tr>
<th>Description available on</th>
<th>Ultrasound n= 67</th>
<th>CT n= 50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presence / absence of:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>tumor</td>
<td>65 (97%)</td>
<td>49 (98%)</td>
</tr>
<tr>
<td>liver metastases</td>
<td>27 (40%)</td>
<td>32 (64%)</td>
</tr>
<tr>
<td>enlarged lymph nodes</td>
<td>9 (13%)</td>
<td>23 (46%)</td>
</tr>
</tbody>
</table>
only 40%. Presence of lymphnodes was poorly described in both US and CT.

Additional investigation in the referral center
After referral to the AMC, an additional US 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 minor additional information 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>
<thead>
<tr>
<th>Additional value</th>
<th>Ultrasound n (%)</th>
<th>CT n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>not present</td>
<td>55 (100)</td>
<td>47 (100)</td>
</tr>
<tr>
<td>present, without a change in treatment</td>
<td>9 (16)</td>
<td>10 (21)</td>
</tr>
<tr>
<td>present, with a change in treatment</td>
<td>29 (53)</td>
<td>22 (47)</td>
</tr>
<tr>
<td></td>
<td>17 (31)</td>
<td>15 (32)</td>
</tr>
</tbody>
</table>

Discussion
The value of re-interpretation of radiological investigations of patients with a suspected pancreatic or hepatobiliary malignancy, who are referred to a specialised center, is considerable, as shown in this study. Discrepancies in interpretation of the same images between radiologists from the referring hospital and the re-interpretation panel are shown. In re-interpreting examinations, that were sufficient for re-interpretation (36 US, 42 CT), additional information was revealed in 24% (19/78); in 14% minor discordances, and in 10% major discordances 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 re-interpretation of CT scans\textsuperscript{4,5} and in 23-42% after re-interpretation of MRI exams\textsuperscript{6,7}.
The relatively large difference in discordances found may be due to differences in the patient populations and to selection. The population in this study may have been changed as 30-50% of the investigations could not be re-interpreted due to limitations of the quality and were therefore excluded from further analysis. If these investigations would have been of better quality one could suggest re-interpretation might have shown even more effect.

Performing re-interpretations has been shown to increase sensitivity and to decrease errors in a variety of radiological examinations\(^{8-10}\). Errors in the interpretation of radiographic studies may be due to perceptual misses or to cognitive errors, such as unfamiliarity with a specific disease, its pattern of spread and its staging criteria or they may be due to lack of state-of-the-art-technique. Insufficient clinical information about a patient may also play a role. Although the members of the panel in this study received the same clinical information, that the radiologist in the referring hospital had at the time of the examination, the members of the panel were aware that all patients were suspected of having pancreatic or hepatobiliary disease. Furthermore the panel reading was done in consensus, to order to mimic the normal approach of discussion of these patients in the multidisciplinary meeting in our hospital. This will not have been the situation in all the referring hospitals, but we considered this the optimal approach in a referral center. Furthermore, consensus reading precluded a Kappa analysis of the variance between the individual members of the panel. Previously substantial variation has been described in interpretation of radiological investigations\(^{11,12}\).

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 are considered to have a resectable tumor after extensive work-up and staging, whereas others refer all 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, and of which description in a radiological report was suggested as being required by the re-interpretation panel.

This may partially be due to the fact that these reports were often made in an early stage of the diagnostic process, in patients with initially unidentified abdominal symptoms and without the clinical suspicion of pancreatic or hepatobiliary disease. An issue may be that there are no guidelines in the Dutch radiological society for the minimal content.
of a radiological report of a US examination or a CT scan in patients with suspected malignant pancreatic or hepatobiliary tumor. Similar problems have been addressed for multiple myeloma \(^{13}\) and lung cancer \(^{14,15}\).

Development of standards or guidelines in order to make radiological reports more uniform and complete may improve the quality of these reports.

The quality of US examinations and CT scans was scored as insufficient for re-interpretation in a relatively large number of cases. One explanation for this finding is that it is difficult to assess a dynamic US examination by means of reading hard copy images. Another factor 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 US examinations and CT scans performed in the tertiary center revealed additional information in a relatively high percentage of patients, 53% and 47%, respectively and were responsible for a change in the treatment strategy in 31% and 32% of patients, respectively. Reasons for the relatively high additional value of these extra investigations are multiple: most important, the presence of dedicated and more experienced radiologists, scanning protocols tailored to these specific diseases together with state-of-the-art equipment. However, we cannot exclude that the time interval between the initial and additional investigations, (although limited to approximately four weeks), allowed the disease to progress, and may have lead to a change in the outcome of radiological investigations and tumor stage.

Several biases may have affected the outcome of this study. Firstly, the classification of the technical quality of the US examinations and CT scans are subjective \(^5\). Secondly, the reference standard is not of uniform validity because pathological proof could not always be obtained. A relatively large number of patients with unresectable tumors were referred back to the initial hospital for palliative care, without histological proof of the diagnosis being available. However, follow-up data in these patients matched with the diagnosis made, as all patients died with disease related symptoms and within 3-22 months after referral.

In summary, among patients with a suspected pancreatic or hepatobiliary malignancy, re-interpretation 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 US or CT examinations resulted in a
change of treatment strategy in 24 patients (30%). Therefore, we conclude that re-
interpretation by an experienced panel potentially benefits patients with a pancreatic or
hepatobiliary malignancy. The expertise of specialised radiologists, possibly facilitated by
recently available telecommunication techniques, could be used to re-evaluate (technically
appropriate) CT scans performed elsewhere. This may result in fewer unnecessary referrals
and patient movements, especially in patients with unresectable tumors.

References

1. Gouma DJ, Nieveen vDE, Obertop H. The standard diagnostic work-up and surgical treatment


4. Kalbhen CL, Yetter EM, Olson MC, Posniak HV, Aranha GV. Assessing the resectability of
pancreatic carcinoma: the value of re-interpreting abdominal CT performed at other institutions.

5. Bechtold RE, Chen MY, Ott DJ, et al.Interpretation of abdominal CT: analysis of errors and

6. Wakeley CJ, Jones AM, Kabala JE, Prince D, Goddard PR. Audit of the value of double reading

7. Friedman DP, Rossetti GF, Flanders AE, et al. MR imaging: quality assessment method and

8. Gollub MJ, Panicek DM, Bach AM, Penalver A, Castellino RA. Clinical importance of re-
interpretation of body CT scans obtained elsewhere in patients referred for care at a tertiary

Interobserver variability and accuracy of computed tomographic assessment of nodal status

10. Thurfjell EL, Lerneval KA, Taube AA. Benefit of independent double reading in a population-

11. Robinson PJ. Radiology's Achilles' heel: error and variation in the interpretation of the Rontgen

