Enhancement patterns of intrahepatic cholangiocarcinoma: comparison between contrast-enhanced ultrasound and contrast-enhanced CT

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ABSTRACT. The aim of this study was to compare the enhancement pattern of intrahepatic cholangiocarcinoma (ICC) on contrast-enhanced ultrasound (CEUS) with that on contrast-enhanced computed tomography (CECT). 40 pathologically proven ICC lesions in 40 patients were evaluated retrospectively with both CEUS and CECT. The enhancement level and pattern in the dynamic phases on both CEUS and CECT were analysed. The diagnostic results of CEUS and CECT before pathological examination were also recorded. During arterial phases, the number of lesions that appeared as (i) peripheral irregular rim-like hyperenhancement, (ii) diffuse heterogeneous hyperenhancement, (iii) diffuse homogeneous hyperenhancement and (iv) diffuse heterogeneous hypoenhancement were 19 (47.5%), 9 (22.5%), 5 (12.5%) and 7 (17.5%), respectively, on CEUS, and 22 (55.0%), 3 (7.5%), 2 (5.0%) and 13 (32.5%), respectively, on CECT (p=0.125). In the portal phase, the number of lesions showing hyperenhancement and hypoenhancement were 1 (2.5%) and 39 (97.5%), respectively, on CEUS, and 15 (37.5%) and 25 (62.5%) on CECT (p=0.0001). CEUS made a correct diagnosis in 32 (80.0%) lesions before pathological examination; CECT made a correct diagnosis in 27 (67.5%) lesions (p=0.18). In conclusion, the enhancement patterns of ICC on CEUS were consistent with those on CECT in the arterial phase, whereas in the portal phase ICC faded out more obviously on CEUS than on CECT. CEUS had the same accuracy as CECT in diagnosing ICCs, and so can be used as a new modality for the characterization of ICC.

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Intrahepatic cholangiocarcinoma (ICC) is a malignant epithelial tumour that originates at the second branch (segmental branch) or the proximal branch of the intrahepatic bile ducts and is the second most common primary malignant tumour in the liver [1–3]. ICC does not cause clinical symptoms in its early stages and thus it can grow large; indeed, the disease is often advanced when it is first detected [4]. Early diagnosis will increase the resectability and thus improve the prognosis of patients with ICCs. Currently, there are no blood tests or tumour markers specific for ICC and the diagnosis mainly depends on imaging procedures [5]. Baseline ultrasound remains the first-line modality for the detection of ICC, but it has difficulty in differentiating this entity from other focal liver lesions because the sonographic findings are non-specific [6, 7]. Patients suspicious for ICC are usually referred for contrast-enhanced CT (CECT) or MRI examination for characterization [8]. The recently introduced low acoustic power contrast-enhanced ultrasound (CEUS) allows depiction of blood haemodynamics and perfusion within focal liver lesions [9], and a previous study has found that ICC has some specific findings at CEUS [10]. In this study, the enhancement patterns of ICCs on CEUS and CECT were compared in order to evaluate the difference between the two modalities in depicting the blood haemodynamics and perfusion within ICCs. In addition, the efficacy of both modalities for diagnosing ICC was investigated.

Methods and materials

Patients

From March 2004 to August 2007, 40 patients with histopathologically proven ICCs who had undergone CECT or CECT examinations in our institution were included in this study retrospectively. The tissue specimens were obtained from surgery (n=33) or ultrasonographically guided percutaneous biopsy (n=7). The patient group consisted of 27 men and 13 women, with a mean age of 58 ± 12 years (range, 26–76 years). 36 patients had a single nodule, whereas 4 patients had multiple nodules. In patients with multiple nodules, only the largest nodule visualized on baseline ultrasound was selected for CEUS evaluation. Therefore, a total of 40 nodules were observed and the size of the lesions was measured.
on baseline ultrasound. Written informed consent was obtained from all patients and the study was approved by the ethical committee of the institution.

**Ultrasound examination**

Ultrasound examinations were performed with either an Acuson Sequoia 512 (Siemens Medical Solutions, Mountain View, CA) \( (n=29) \) or an Aplio XV (Toshiba, Tokyo, Japan) \( (n=11) \) scanner depending on the availability of the machines. The 4V1 vector transducer with a frequency range of 1.0–4.0 MHz was used for the Acuson Sequoia 512 scanner; the 375BT convex transducer with a frequency range of 1.9–6.0 MHz was used for the Aplio XV scanner. A low acoustic power (mechanical index, 0.2), real-time, contrast-specific CEUS mode of contrast pulse sequencing (CPS; Siemens Medical Solutions) was incorporated for the Acuson Sequoia 512 scanner, whereas contrast harmonic imaging (CHI; Toshiba) was incorporated for the Aplio XV scanner.

The contrast agent used was SonoVue* (BRI; Bracco SpA, Milan, Italy), which was administrated intravenously at a dose of 2.4 ml per injection in a bolus fashion (within 1–2 s), followed by a flush of 5 ml of normal saline.

Baseline ultrasound was firstly performed to scan the whole liver; the target lesion was determined, which was subsequently resected or biopsied. The images that clearly exhibited lesion characteristics on baseline ultrasound, including size, echogenicity, shape, boundary, focal bile duct dilation around the tumour and calculus, were recorded. The CPS or CHI mode was initiated after baseline ultrasound examination. In the contrast-enhanced study, the mechanical index value ranged from 0.15–0.21 for CPS and no larger than 0.1 for CHI. Upon initiation of the SonoVue injection, the timer was activated simultaneously. The target lesion was observed continuously for 6 min, without alteration of the imaging setting of the scanner. The entire process, including arterial (8–30 s from the beginning of contrast agent administration), portal (31–120 s), and late (121–360 s) phases, was stored in the hard disk incorporated into the scanner. All of the baseline ultrasound and CEUS examinations were performed by two experienced

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**Figure 1.** Periphery cholangiocarcinoma in a 40-year-old man. (a) A 7.5 cm nodule (arrows) in segment 5 shows hypoechogenicity on baseline ultrasound. (b) Contrast-enhanced ultrasound (CEUS) shows peripheral irregular rim-like hyperenhancement (arrows) in the nodule during the arterial phase (13 s after contrast agent administration). (c) In the portal phase of CEUS (87 s after contrast agent administration), the nodule (arrows) shows hypoenhancement compared with adjacent liver tissue. (d–f) The nodule (arrow) presents as hypootenuation on (d) unenhanced CT, irregular peripheral rim-like hyperenhancement (arrows) in (e) the arterial phase, and hypoenhancement (arrows) in (f) the portal phase on contrast-enhanced CT.
investigators with more than 5 years’ experience in liver CEUS.

**Contrast-enhanced CT**

CECT examination was performed using a Toshiba Xpress/SX single-slice helical CT scanner (Tokyo, Japan) or Toshiba Aquilion 64-slice helical CT scanner (Tokyo, Japan) within 14 days before or after CEUS examination. No treatment was performed on the ICCs during the period between CEUS and CECT examinations. Single-slice helical CT parameters included 5 mm collimation, a pitch of 1.0, 120 kV and 250 mAs. The 64-slice helical CT study protocol involved a 0.5 × 64 mm collimation, 120 kV and 150–200 mAs. The standard dual-phase scan procedure was used. After an unenhanced helical sequence scan through the liver, 50–100 ml (1.5 ml kg\(^{-1}\)) of non-ionic iodinated contrast material (Ultravist; Schering, Berlin, Germany) was administered via the antecubital vein by power injection at a rate of 3 ml s\(^{-1}\) (single-slice helical CT) or 4 ml s\(^{-1}\) (64-slice helical CT). The arterial phase sequence was obtained 25–32 s after injection, followed by a portal venous phase sequence at 50–60 s.

**Data analysis**

The images from CEUS were analysed in consensus by two investigators, and the CECT images by two radiologists, who were not involved in the sonographic or CT scanning and were unaware of the clinical histories, histopathological results and other imaging findings of the patients. The echogenicity of the lesion on baseline ultrasound and attenuation on unenhanced CT with respect to the surrounding normal liver tissue, as well as focal bile duct dilation around the tumour and calculus, were evaluated. On both CEUS and CECT, the enhancement level and pattern, as well as the changes associated with the dynamic phases, were analysed.

On CEUS, the highest enhancement of the lesion was considered if different enhancement levels were present during the arterial phase. The tumour enhancement levels on the arterial phase on CEUS were divided into (i) non-enhancement, (ii) hypoenhancement, (iii) isoenhancement and (iv) hyperenhancement, compared with those of the adjacent liver parenchyma, in accordance with “Guidelines for the use of contrast agents in ultrasound” [11].

The enhancement pattern was determined by evaluating images obtained during the early phase of enhancement (typically 10–30 s after contrast agent administration), when the enhancement of the tumour had just commenced. The enhancement pattern on CECT was determined by evaluating the arterial phase images. The enhancement pattern of the lesion was classified as follows [10]:

- **Non-enhancement** — no appearance of contrast material in the lesion.
- **Peripheral irregular rim-like hyperenhancement** — irregular rim-like hyperenhancement at the peripheral portion of the lesion and inhomogeneous hypoenhancement at the central portion, with strip-like enhancement extending to the central portion of the lesion.
- **Diffuse heterogeneous hyperenhancement** — heterogeneous hyperenhancement at both the periphery and the central portion of the lesion.
- **Diffuse homogeneous hyperenhancement** — homogeneous hyperenhancement at both the periphery and the central portion of the lesion.
- **Diffuse heterogeneous hypoenhancement** — heterogeneous hypoenhancement at both the periphery and the central portion of the lesion.

The intratumoral blood vessels that appeared during arterial phases were also evaluated on both CEUS and CECT.

The enhancement level of the lesion at the end of the portal phase on CECT was determined. In this late phase, the enhancement level was recorded either when the lesion showed hypoenhancement or 360 s after contrast agent administration. A comparison of the enhancement appearance in the late phase between CEUS and CECT was not performed as the routine scanning protocol of CECT did not include late-phase scanning in our institution.

To evaluate the accuracy of CEUS and CECT in diagnosing ICC prior to pathological examination, the diagnostic results of CEUS and CECT (which were made by experienced radiologists) were also recorded. The sonographic diagnostic criteria for ICC were as follows: a non-cirrhotic liver; variable echogenicity; an irregular lesion margin; peripheral bile duct dilatation or calculus on baseline ultrasound; peripheral irregular rim-like hyperenhancement, heterogeneous hypoenhancement or heterogeneous hyperenhancement during the arterial phase; and hypoenhancement during the portal and late phases on CECT [10, 12–14]. The diagnostic criteria of CECT were based on previous studies [6, 15–17].

**Statistical analysis**

The quantitative data were expressed as mean ± standard deviation. The McNemar test was used to evaluate differences between paired qualitative data. The enhancement pattern of the lesion in terms of lesion size was identified by means of the χ\(^2\) test. Two-tailed \(p<0.05\) was considered statistically significant. Statistical analyses were performed using the SPSS 11.0 software package (SPSS Inc., Chicago, IL).

**Results**

On baseline ultrasound, the mean diameter of all lesions was 6.7 ± 2.5 cm (range, 2.1–15.5 cm). The numbers of lesions ≤3.0 cm, 3.1–5.0 cm and >5.0 cm were 2, 8 and 30, respectively. The depth from the body surface to the bottom of the lesion ranged from 3.7 cm to 16.0 cm (mean, 8.2 ± 2.8 cm). The numbers of lesions that showed hypoechogenicity, hyperechogenicity and mixed echogenicity were 16 (40.0%), 8 (12.5%) and 19 (47.5%), respectively. On unenhanced CT, 39 (97.5%) lesions were hypoattenuating relative to the liver parenchyma; the remaining 1 lesion (2.5%) was hyperattenuating.
Intrahepatic bile duct dilation around the tumour was present in 22 (55.0%) lesions, and calculus in the bile duct was seen in 11 (27.5%) lesions on both CEUS and CECT.

During the arterial phases of CEUS and CECT, four types of enhancement pattern were observed: (i) peripheral irregular rim-like hyperenhancement (Type I) (Figure 1); (ii) diffuse heterogeneous hyperenhancement (Type II) (Figure 2); (iii) diffuse homogeneous hyperenhancement (Type III); and (iv) diffuse heterogeneous hypoenhancement (Type IV) (Figure 3). The numbers of the lesions that showed the above-mentioned patterns (Types I–IV) were 19 (47.5%), 9 (22.5%), 5 (12.5%) and 7 (17.5%), respectively. On CECT, the numbers were 22 (55.0%), 3 (7.5%), 2 (5.0%) and 13 (32.5%), respectively. The McNemar test indicated no significant difference between CEUS and CECT with respect to either the enhancement level (p=0.109) or the enhancement pattern (p=0.125) (Table 1). There were significant differences among the four types of enhancement pattern by lesion size on CEUS (p=0.017) (Table 2).

In the portal phase, 39 (97.5%) lesions were hypoenhancing on CEUS, whereas 25 (62.5%) were hypoenhancing on CECT (McNemar test, p=0.0001) (Table 3; Figure 2).

Table 1. The enhancement patterns of intrahepatic cholangiocarcinoma during the arterial phase on CEUS and CECT

<table>
<thead>
<tr>
<th>CEUS</th>
<th>Type I</th>
<th>Type II</th>
<th>Type III</th>
<th>Type IV</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEUS</td>
<td>17 (42.5)</td>
<td>2 (5.0)</td>
<td>1 (2.5)</td>
<td>2 (5.0)</td>
<td>22 (55.0)</td>
</tr>
<tr>
<td>Type I</td>
<td>0 (0)</td>
<td>2 (5.0)</td>
<td>1 (2.5)</td>
<td>0 (0)</td>
<td>3 (7.5)</td>
</tr>
<tr>
<td>Type II</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>2 (5.0)</td>
<td>0 (0)</td>
<td>2 (5.0)</td>
</tr>
<tr>
<td>Type III</td>
<td>2 (5.0)</td>
<td>5 (12.5)</td>
<td>1 (2.5)</td>
<td>5 (12.5)</td>
<td>13 (32.5)</td>
</tr>
<tr>
<td>Type IV</td>
<td>19 (47.5)</td>
<td>9 (22.5)</td>
<td>5 (12.5)</td>
<td>7 (17.5)</td>
<td>40 (100.0)</td>
</tr>
</tbody>
</table>

Data given are the number of lesions; data in parentheses are expressed as the percentage of total lesions. The McNemar test indicates no significant difference between CEUS and CECT (p=0.125).

CEUS, contrast-enhanced ultrasound; CECT, contrast-enhanced CT; Type I, peripheral irregular rim-like hyperenhancement; Type II, diffuse heterogeneous hyperenhancement; Type III, diffuse homogeneous hyperenhancement; Type IV, diffuse heterogeneous hypoenhancement.
Enhancement patterns of ICC: comparison between CEUS and CECT

Table 2. The enhancement pattern of the intrahepatic cholangiocarcinoma lesions on contrast-enhanced ultrasound according to lesion size

<table>
<thead>
<tr>
<th>Enhancement pattern</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td></td>
</tr>
<tr>
<td>≤3.0cm</td>
<td></td>
</tr>
<tr>
<td>Type I</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Type II</td>
<td>3 (7.5)</td>
</tr>
<tr>
<td>Type III</td>
<td>1 (2.5)</td>
</tr>
<tr>
<td>Type IV</td>
<td>2 (5.0)</td>
</tr>
<tr>
<td>Total</td>
<td>6 (15.0)</td>
</tr>
<tr>
<td>3.1–5.0cm</td>
<td></td>
</tr>
<tr>
<td>Type I</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Type II</td>
<td>2 (5.0)</td>
</tr>
<tr>
<td>Type III</td>
<td>2 (5.0)</td>
</tr>
<tr>
<td>Type IV</td>
<td>8 (20.0)</td>
</tr>
<tr>
<td>Total</td>
<td>12 (30.0)</td>
</tr>
<tr>
<td>&gt;5.0cm</td>
<td></td>
</tr>
<tr>
<td>Type I</td>
<td>16 (40.0)</td>
</tr>
<tr>
<td>Type II</td>
<td>7 (17.5)</td>
</tr>
<tr>
<td>Type III</td>
<td>2 (5.0)</td>
</tr>
<tr>
<td>Type IV</td>
<td>30 (75.0)</td>
</tr>
<tr>
<td>Total</td>
<td>35 (87.5)</td>
</tr>
</tbody>
</table>

Data given are the number of lesions; data in parentheses are expressed as the percentage of total lesions. \( \chi^2 \) test indicates significant differences among the four types of enhancement pattern according to lesion size on CEUS (\( p = 0.017 \)).

Type I, peripheral irregular rim-like hyperenhancement; Type II, diffuse heterogeneous hyperenhancement; Type III, diffuse homogeneous hyperenhancement; Type IV, diffuse heterogeneous hypoenhancement.

Figure 4). In the late phase, all 40 nodules showed hypoenhancement on CEUS.

Intratumoral vessels were exhibited in 20 lesions (50.0%) on CEUS and 9 lesions (22.5%) on CECT (McNemar test, \( p = 0.019 \)). A wedge or patch-like hyperenhanced area in adjacent normal liver was visualized for 5 lesions (12.5%) during the arterial phase on CEUS and for 8 lesions (20.0%) on CECT (McNemar test, \( p = 0.025 \)).

CEUS correctly diagnosed 32 (80.0%) lesions prior to pathological examination. Among the incorrectly diagnosed lesions, six showing diffuse homogeneous hyperenhancement in the arterial phase and hypoenhancement in the portal phase were misdiagnosed as hepatocellular carcinoma (HCC); two lesions showing peripheral rim-like hyperenhancement in the arterial phase and hypoenhancement in the portal phase were misdiagnosed as metastatic liver cancer (MLC). CECT made a correct diagnosis in 27 (67.5%) lesions. There were four lesions misdiagnosed as HCC, three lesions misdiagnosed as MLC and six lesions misdiagnosed as inflammatory masses. The McNemar test indicated no significant difference in the diagnostic accuracy between CEUS and CECT (\( p = 0.18 \)) (Table 4).

Discussion

The most common imaging finding of ICC on baseline ultrasound is of a solid mass with irregular borders [4, 13], although this is non-specific. Ancillary findings, including perilesional bile duct dilation, calculus in the lesion or bile duct and capsular retraction [18], are helpful to aid diagnosis, but it is still difficult for baseline ultrasound to distinguish ICC from other liver lesions such as HCC, liver metastasis and inflammatory liver lesions [13].

CECT has the advantages of improved resolution and better anatomic detail, and facilitates the investigation of intralobular haemodynamics. The accuracy of CECT in diagnosing ICC was ~70% [19]. On unenhanced CT, ICC is depicted as a well-defined mass of markedly low attenuation with irregular borders. On enhanced CT, the typical appearance is of a mass that demonstrates thin, mild, rim-like enhancement at the periphery and markedly low intratumoral attenuation with amorphous areas of slightly high attenuation during both the arterial and portal venous phases [6, 15, 16].

Like CECT, the recently introduced real-time CEUS allows depiction of the intralobular haemodynamics and blood perfusion in ICCs [9, 10, 20]. Previous studies have shown that ICCs have some special features on CEUS during the arterial phase. ICCs show three main enhancement patterns: (i) peripheral rim-like hyperenhancement, (ii) inhomogeneous hypoenhancement of the whole tumour and (iii) inhomogeneous hyperenhancement [14, 21, 22], with visualization rates of 44.4%, 44.4% and 11.2%, respectively [10]. These results suggest that CEUS might be used as a characterization tool for ICC. Nevertheless, no studies have yet been carried out to compare the enhancement patterns of ICC on CEUS and CECT.

In the current study, the typical enhancement pattern — irregular rim-like hyperenhancement at the periphery of the lesion with strip-like enhancement extending to the central portion — was demonstrated in the majority (47.5%) of ICCs on CEUS, which was consistent with findings on CECT (visualization rate of 52.5%). Three other types of enhancement pattern were visualized on both CEUS and CECT, including diffuse heterogeneous hyperenhancement, diffuse heterogeneous hypoenhancement and diffuse homogeneous hyperenhancement. No significant difference in the visualization of the four enhancement patterns was found between CEUS and CECT. The different enhancement patterns may relate to different pathological components in the tumour [23]. When there is abundant fibrous stroma in the tumour, it might show hypoenhancement in the arterial phase. If the ICC is rich in tumour cells at the peripheral portion and fibrosis occurs in the central portion, it might appear as irregular peripheral rim-like hyperenhancement. Conversely, the tumour might show diffuse hyperenhancement if the major component is tumour cells and there is no central necrosis [2, 4, 17, 24, 25]. Our study indicated that the enhancement pattern may also correspond to tumour size, i.e. smaller lesions tend to show homogeneous hyperenhancement that is hard to differentiate from HCC, whereas larger lesions tend to show diverse enhancement patterns. Zhang et al [26] postulated that this phenomenon may reflect pathological change along with tumour growth, i.e. larger tumours may compress central vessels as they grow, resulting in central hypovascularity or necrosis.

In this series, six ICCs showed hyperenhancement immediately after contrast agent injection; washout was very fast, leading to hypoenhancement 24–27 s after contrast agent administration on CEUS. However, the six ICCs were depicted as hypoenhancement during the arterial phase on CECT. This difference may be attributed to the real-time scanning characteristic of CEUS. The CEUS feature of continuous and dynamic observation facilitates documentation of the entire enhancement process, whereas CECT might miss the information during the time window and thus only hypoenhancement was visualized.

On CT, most (97%) ICCs showed no apparent change between the hepatic arterial and the portal venous
phases, remaining isoattenuating or slightly hyperattenuating [15, 27–29]. However, most (97.5%) ICCs in this series showed enhancement fadeout and appeared as hypoenhancement during the portal venous and delayed phases on CEUS, which is a typical feature of liver malignancy [12, 30]. The phenomenon might be explained by the fact that the ultrasound contrast agent is a real blood pool agent and thus it does not diffuse through the vascular endothelium into the interstitium. Conversely, the CT contrast agent can diffuse into the interstitial spaces of the tumour slowly from the intratumoral vessels, and clear up slowly owing to the abundant fibrous tissue and slow blood flow in ICCs; therefore, even delayed tumour enhancement was visualized [27, 31].

A significant difference in the ability to exhibit intratumoral vessels was found between CEUS and CECT, with the visualization rates being 50% and 23%, respectively. This may reflect the real-time scanning, as well as the high spatial and temporal resolution, of CEUS, which can record the display of intratumoral vessels completely. Conversely, the pathological change

| Table 3. Enhancement extent of intrahepatic cholangiocarcinoma during the portal phase on CEUS and CECT |
|-----------------------------|-----------------------------|-----------------------------|-----------------------------|
|                             | CEUS                        | CECT                        |
|                             | Hyperenhancement            | Hypoenhancement             | Total                       |
| Hyperenhancement            | 1 (2.5)                     | 14 (35.0)                   | 15 (37.5)                   |
| Hypoenhancement             | 0 (0)                       | 25 (62.5)                   | 25 (62.5)                   |
| Total                       | 1 (2.5)                     | 39 (97.5)                   | 40 (100.0)                  |

Data given are the number of lesions; data in parentheses are expressed as the percentage of total lesions. The McNemar test indicates a significant difference between CEUS and CECT (p=0.0001). CEUS, contrast-enhanced ultrasound; CECT, contrast-enhanced CT.
of a wedge or patch-like hyperenhanced area in adjacent liver during the arterial phase was visualized on both CEUS and CECT, and no difference between these modalities was detected. The phenomenon is a reflection of hepatic arterial flow increasing to compensate for the decrease in portal venous flow, which is caused by the narrowing or obstruction of the portal vein from invasion or extrinsic compression by the tumour [6]. However, this finding is non-specific and can be found in other focal liver lesions.

Initial results found that the diagnostic accuracy of CEUS and CECT for ICCs before pathological examination was almost the same, which suggested that CEUS might also be used as a characterization tool for ICCs. The enhancement patterns of ICC are variable; some might be characteristic, such as peripheral irregular rim-like enhancement, whereas others should be taken into consideration in order to differentiate from other more common intrahepatic masses, such as MLC and HCC. Hypovascular metastases, especially from adenocarci-

Table 4. Diagnostic results of CEUS and CECT prior to pathological examination

<table>
<thead>
<tr>
<th></th>
<th>CEUS</th>
<th>CECT</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Correct diagnosis</td>
<td>Wrong diagnosis</td>
<td></td>
</tr>
<tr>
<td>Correct diagnosis</td>
<td>25 (62.5)</td>
<td>2 (5.0)</td>
<td>27 (67.5)</td>
</tr>
<tr>
<td>Wrong diagnosis</td>
<td>7 (17.5)</td>
<td>6 (15.0)</td>
<td>13 (32.5)</td>
</tr>
<tr>
<td>Total</td>
<td>32 (80.0)</td>
<td>8 (20.0)</td>
<td>40 (100.0)</td>
</tr>
</tbody>
</table>

Data given are the number of lesions; data in parentheses are expressed as the percentage of total lesions. The McNemar test indicates no significant difference in diagnostic efficacy between CEUS and CECT (p=0.18).

CEUS, contrast-enhanced ultrasound; CECT, contrast-enhanced CT.
noma of the gastrointestinal tract, frequently show a peripheral rim-like enhancement pattern similar to that of ICC [12, 14]. Absence of the possible primary site, other ancillary findings (e.g. bile duct dilation) and the irregular shape of the lesion can be clues useful for differentiation [6]. It is difficult to distinguish HCC from some ICCs showing diffuse hyperenhancement in the arterial phase and subsequent washout. A background of virus hepatitis B or C, the presence of liver cirrhosis, arterial phase and subsequent washout. A background of some ICCs showing diffuse hyperenhancement in the differentiation [6]. It is difficult to distinguish HCC from other liver tumours, and a prospective protocol are compared. The comparison of diagnostic performance efficacies of CEUS and CECT for ICCs were not fully related to the different characteristics of sonographic contrast agents and CT contrast material, as mentioned above. The other limitation was that the diagnostic accuracies of CEUS and CECT for ICCs were not fully compared. The comparison of diagnostic performance using receiver operating characteristic analysis, including other liver tumours, and a prospective protocol are mandatory in future studies.

Conclusions

The enhancement patterns of ICCs on CEUS were consistent with those on CECT in the arterial phase, whereas in the portal phase ICCs faded out more obviously on CEUS than on CECT. CEUS had the same accuracy as CECT for ICCs, and thus could be used as a new modality for the characterization of ICCs.

References


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