Prediction of pancreatic necrosis in early stage of acute pancreatitis using subtraction color map images created from contrast-enhanced and unenhanced CT.

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Disclosure of commercial interest

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**Background and Aim**

- **Pancreatic necrosis (PN)**
  2-5% acute pancreatitis patients develop PN
  The mortality rate with PN : 30%.

- **Difficulty of early diagnosis of PN**
  Accuracy of Contrast enhanced CT (CE-CT) alone in predicting PN within 72 hours of the onset : 0 - 53% \(^1,2\).
  Decrease in blood flow may be difficult to detect with CE-CT alone due to hemorrhage in PN or focal fat infiltration in viable pancreas.

- **Imaging subtraction technique** has been used in various clinical applications such as differentiating enhancing renal mass from hemorrhagic cyst with use of MR \(^3\).

- The aim of this study is to investigate the usefulness of **subtraction color map images from CE and unenhanced (NC)-CT** for diagnosis of PN in the early stage of acute pancreatitis.

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Patient and Method 1

• **48 patients** who had NC-CT and CE-CT within 3 days from the onset

• **Scanning protocols**

  **NC-CT and Single phase CE-CT protocol (n=9)**

  Scan delay of 70 sec after administration of 140 mL of IV contrast material at 3 mL/sec.

  NC-CT and **Dual-phase CE-CT protocol (n=39)**

  *Scan delays of* 50 and 70 sec at 3 mL/sec x 140 mL, 45 and 65 sec at 4 mL/sec x 140 mL, and 40 and 60 sec at 5 mL/sec x 140 mL.

• **Subtraction (CE-CT - NC-CT) color map images** were created for pancreatic and hepatic phases after 3D registration.

  **Color map setting**: Enhancement of 15 HU or less is coded with the color **purple** which was used as threshold for diagnosis of PN.
Patient and Method 2

- **Image Review:** CT scans were reviewed by three blinded radiologists in the following sequence; CE-CT only, NC-CT + CE-CT, subtraction color map images + CE-CT.

Reviewers diagnosed PN when pancreatic parenchyma showed 1 cm² or larger purple area. The presence of PN was evaluated using a 5-point confidence scale for each image set.

- **The standard of reference for development of PN** was follow-up CT or MR performed at 1 week or later. When the patient was discharged from hospital within 1 week without a CT or MR, PN was considered absent.

- **Sensitivity, specificity, accuracy,** and the **area under the ROC curve (AUC)** for diagnosis of PN were calculated for each image set using confidence level of 3 or greater as a threshold.
**Result; Subtracted Color Map showed higher accuracy for prediction of PN**

<table>
<thead>
<tr>
<th>Reviewer</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CE-CT</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensitivity</td>
<td>81.8 (9 / 11)</td>
<td>81.8 (9 / 11)</td>
<td>72.7 (8 / 11)</td>
</tr>
<tr>
<td>Specificity</td>
<td>89.2 (33 / 37)</td>
<td>78.4 (29 / 37)</td>
<td>86.5 (32 / 37)</td>
</tr>
<tr>
<td>Accuracy</td>
<td>87.5 (42 / 48)</td>
<td>79.2 (38 / 48)</td>
<td>83.3 (40 / 48)</td>
</tr>
<tr>
<td>AUC</td>
<td>0.96</td>
<td>0.91</td>
<td>0.90</td>
</tr>
<tr>
<td><strong>NC-CT + CE-CT</strong></td>
<td></td>
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</tr>
<tr>
<td>Sensitivity</td>
<td>81.8 (9 / 11)</td>
<td>90.9 (10 / 11)</td>
<td>72.7 (8 / 11)</td>
</tr>
<tr>
<td>Specificity</td>
<td>89.2 (33 / 37)</td>
<td>81.1 (30 / 37)</td>
<td>86.5 (32 / 37)</td>
</tr>
<tr>
<td>Accuracy</td>
<td>87.5 (42 / 48)</td>
<td>83.3 (40 / 48)</td>
<td>83.3 (40 / 48)</td>
</tr>
<tr>
<td>AUC</td>
<td>0.96</td>
<td>0.94</td>
<td>0.90</td>
</tr>
<tr>
<td><strong>Subtracted Color Map + CE-CT</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensitivity</td>
<td>100.0 (11 / 11)</td>
<td>100.0 (11 / 11)</td>
<td>81.8 (9 / 11)</td>
</tr>
<tr>
<td>Specificity</td>
<td>100.0 (37 / 37)</td>
<td>89.2 (33 / 37)</td>
<td>91.9 (34 / 37)</td>
</tr>
<tr>
<td>Accuracy</td>
<td>100.0 (48 / 48) *</td>
<td>91.7 (44 / 48) *</td>
<td>89.6 (43 / 48)</td>
</tr>
<tr>
<td>AUC</td>
<td>1.00</td>
<td>0.99</td>
<td>0.96</td>
</tr>
</tbody>
</table>

Data are percentages or area under the curve. Numbers in parentheses were used to calculate the percentages. Accuracy was compared between subtracted color map images + CE-CT versus CE-CT alone or NC-CT + CE-CT using McNemar test. * \( P<0.05 \)
Cases

Case 1
- **Initial scan - Hepatic phase**
  - Radiologists interpreted pancreatic necrosis as probably absent.
- **Initial scan - Subtraction color map**
  - Radiologists interpreted as pancreatic necrosis definitely present in tail (purple area, arrows).
- **Follow-up scan 3 weeks later**
  - Pancreatic necrosis is present involving pancreatic body and tail.

Case 2
- **Initial scan - Hepatic phase**
  - Radiologists interpreted pancreatic necrosis as probably present in head (pink arrow).
- **Initial scan - Subtraction color map**
  - Radiologists interpreted as pancreatic necrosis definitely absent.
- **Follow-up scan 3 weeks later**
  - Pancreatic necrosis is absent.
Conclusion

• Addition of subtraction color map image set significantly improved the detection of PN in early stage of acute pancreatitis compared to CE-CT image set alone or combined NC-CT + CE-CT image set in two of three reviewers.

• In the third reviewer, the accuracy improved by 6%, but the difference was not statistically significant.

• Therefore, subtracted color map images created from CE-CT and NC-CT are useful in the diagnosis of PN in the early stage of acute pancreatitis.