Abstract. Aim: To assess the need for surgical treatment in patients with acute abdominal pain in a prospective randomized study. Patients and Methods: Initially 203 patients with acute abdominal pain were randomized to the routine abdominal computed tomography CT (rCT, n=118), or selective abdominal CT group (sCT, n=85) over a period of 16 months. Ninety-three of the randomized patients (45.8%) underwent the study design and were reached for follow-up at three months. Results: Diagnostic accuracy improved significantly in the rCT group (p<0.001). The surgeon’s assessment of the need for surgery changed more often in the rCT group than in the sCT group (78.7% vs. 46.9%, p=0.002). The confidence to treat operatively increased significantly in the rCT vs. the sCT group (65.6% vs. 40.6%, p=0.028). The rCT was the only independent parameter for the change of the assessment of surgery. Conclusion: Routine CT allows for more confidence in decision making for the surgical treatment of patients with acute abdominal pain.

The major methods used to investigate the need for surgery in patients with acute abdominal pain (AAP) are clinical examination, laboratory investigations, abdominal ultrasonography, and computed tomography (CT) (1-5). The advantage of CT in the diagnosis of the cause of AAP over other diagnostic tools has been shown in earlier studies and abdominal CT is quite a routine method in emergency departments (EDs) (6-9). However, there are surgical EDs where abdominal CT is not available 24 h a day.

Furthermore, it is questionable whether the CT should be performed for every patient with AAP at hospital admission (10, 11). Sala et al. in a randomized trial showed that early routine CT improved the diagnostic accuracy in patients with non-specific abdominal pain, reducing unnecessary operations (12), but the benefits of routine abdominal CT in reducing hospital admissions and shortening hospital stays are controversial. The impact of early abdominal CT on the mortality or the decision for emergency laparotomy in patients with AAP is also yet to be established.

To our knowledge, the use of the routine vs. selective abdominal CT in the assessment of the need for surgery in the patients with AAP is rarely reported. This study’s hypothesis was that patients with AAP undergoing routine abdominal CT would more often require change in the assessment of surgery than would patients with selective abdominal CT. We therefore designed the present study to investigate the impact of the abdominal CT in patients with AAP.

Patients and Methods

This study was a sub-analysis of a prospective, randomized, controlled single-Center trial conducted at a university teaching hospital with approximately 11,000 annual surgical ED visits. The methods have been described in our earlier report (13). The study was approved by the Research Ethics Committee of the Hospital District of Northern Savo, Kuopio, Finland (DNRO 82/2008, June 25, 2008), and was registered in the ClinicalTrials.gov database (ClinicalTrials.gov, Identifier: NCT00870766, Consort diagram, Figure 1).

The primary end-points were correct diagnosis within 24 h after hospital admission and assessment of the need for surgery. The golden standard for correct diagnosis was ‘the 3 months of follow-up’. The secondary end-points were the frequency of discharge from the ED, and the length of the hospital stay.

Study design. After obtaining written informed consent, the recruited patients were randomly assigned to either routine (rCT) or selective (sCT) abdominal CT groups. The on-call surgeon using closed envelopes performed randomization. Patients included had their
medical history recorded, physical examination, a fixed set of laboratory tests, and a pain intensity score using a visual analog scale (VAS). All patients with upper abdominal pain had a chest radiograph and patients over the age of 45 years had a routine electrocardiogram in order to exclude cardiogenic and intra-thoracic causes for acute pain. Based on this information, the initial diagnosis was set down, and the estimation of the need for the possible surgical therapy was recorded with the five point Likert scale: strongly certain: 1; certain: 2; unclear: 3; uncertain: 4; strongly uncertain: 5.

All patients in the rCT group underwent contrast-enhanced abdomino-pelvic CT imaging within 24 hours of admission. The CT method is shown in our earlier report (13). In the sCT group, abdominal CT was performed if considered necessary. Other imaging investigations were performed based on clinical grounds: ultrasonography for patients with suspected cholecystitis, and plain radiographs for patients with suspected bowel obstruction. The second assessment of diagnosis (preoperative diagnosis) of the patient and the need for surgery was established in both groups within 24 h after randomization using the same formula as in the initial assessment. The change in the assessment for the surgical treatment was established as a change in the Likert value between the two time points. The change in the assessment was recorded as being more confident when the Likert value changed from 3 to 1, 2, 4 or 5, or from 2 or 4 to 1 or 5.

The treatment of the patients followed general surgical principles and was similar in both study groups (13). The final diagnosis of the cause of AAP was a summary of clinical and imaging findings. It was defined as the diagnosis at discharge with definite cases. For patients with non-specific abdominal pain, the final diagnosis was confirmed by examinations at three months of follow-up. The three-month time frame was chosen in order to detect possible complications. The group of the investigators checked the reliability of all diagnoses.

A total of 1600 patients with AAP attended the ED during the study period of January 2009 to May 2010. The present study of the 203 randomized patients focuses on the impact of the routine vs. selective abdominal CT on the surgical decision-making and the need for possible surgical therapy at the 24-h time-point after randomization. Ninety-three (45.8%) of the randomized patients followed the study design and were reached for follow-up at three months (Figure 1).

**Statistical analysis.** The descriptive statistics include the median and range for continuous variables, and the absolute and relative frequencies for the nominal variables. The proportions between the groups were compared with the x² test or in small numbers with the Fisher’s exact test, and within the groups with the McNemar test. The Mann-Whitney U-test was used to compare the continuous variables. Multiple logistic regression analysis for the binary outcome was performed, and an odds ratio including the 95% asymptotic confidence interval was calculated for the independent variables. A value of p<0.05 defined a statistically significant
Results

The two study groups were comparable for gender and age (Table I). No difference was found between the study groups in self-assessed pain intensity [median VAS score (range)=6 (1-10) and 6 (2-10), respectively, \( p=0.475 \)]. Abdominal CT was performed in 17 patients (53.1\%) of the sCT group.

The distribution of the final diagnoses is listed in Table I. Thirty-three patients had operations: 22 patients (36.0\%) in the rCT group and 11 patients (34.4\%) in the sCT group \( (p=0.871) \). Acute appendicitis was the most common operative diagnosis and accounted for 63.6\% of the diagnoses in both groups (14/22 and 7/11, respectively).

None of the operated patients had a diagnosis of NSAP. The median length of hospital stay was 1 day (range 0-31 days) in the rCT group, and 2 days (range 0-19 days) in the sCT group \( (p=0.373) \). The number of patients discharged from the ED was comparable in the groups [26/61 (42.6\%) and 13/32 (40.6\%), respectively; \( p=0.664 \)]. There was no mortality in the study groups.

The results of the diagnostic accuracy are presented in Table II. There was no difference between the groups in the diagnostic accuracy of initial diagnoses and this reflects the similarity of the groups before randomization \( (p=0.833) \).

The on-call surgeon’s assessment of the need for surgical therapy changed between the time-points significantly more often in the rCT-than in the sCT-group \[48/61 (78.7\%) and 15/32 (46.9\%); \( p=0.002\]}. When we report the change of certainty/uncertainty of the surgical therapy, the Likert scale shows that the confidence to treat operatively or not increased significantly in the rCT vs. sCT group \( (65.6\% \text{ vs. } 40.6\%, p=0.028) \).

In the multiple logistic regression analysis, the independent parameters for the accuracy of preoperative diagnosis were: being in the rCT group, younger age (<65 years), and correct initial diagnosis. The only independent parameter predictive of the change of the surgeon’s assessment for surgery was being in the rCT group (Table III).

Discussion

The present study compared the routine and selective abdominal CT in the diagnosis of the cause of AAP. Our main finding was that routine CT changed the surgeon’s assessment for treatment of patients with AAP and gave additional confidence to their surgical decision-making. The routine use of the CT for every patient with AAP resulted in more accurate diagnoses than the selective use of abdominal CT, but it did not affect patient mortality or the frequency of the emergency laparotomy. The on-call surgeon changed the assessment of the need for surgical treatment for the patient in the rCT group more often, which may reflect more specific treatment and better diagnostic work-up of the patients with AAP.

The accuracy of the clinical diagnosis was about 50\% after the first contact (initial diagnosis) in both study groups and after 24 h, it rose to 86\% in the rCT group. Similar accuracy figures have been reported in EDs. The ‘old’ clinical practice of the cautious follow-up of patients with AAP with repetition of physical examination is questioned by the requirement for efficacy in healthcare. The correct diagnosis and treatment have determined quickly and safely (14, 15). We did not find any difference in the discharge rate from the ED or the length of the hospital stay between the study groups. In the randomized studies, no significant difference in hospital stay was found either (12, 16). Moreover in this study, there were no unnecessary operations in the sCT group. Therefore, despite the better diagnostic accuracy in the rCT group, selective CT imaging was also sufficiently safe and accurate here.

In the multiple regression analysis of our results, routine CT imaging, and the age of the patient had the most predictive impact on the diagnostic accuracy. We found that patients under 65 years more often had a correct diagnosis than did older patients. In addition, there was a tendency for the improvement in diagnosis at the 24-h time-point in the rCT group, especially among older patients when compared to the sCT group. However, this was not statistically significant due to the low number of patients. The diagnosis of the cause of
AAP is more difficult in elderly patients and CT diagnostics is also more challenging in the elderly with AAP (17, 18). Acute appendicitis was the most common diagnosis in younger patients, whereas the older patients had clinically unpredictable diagnoses, such as malignancy and vascular disease. In this consideration, abdominal CT could be recommended routinely for elderly patients. The additional radiation exposure may also be more acceptable to elderly patients.

We have recently shown that routine CT results in higher costs than the selective use of CT, and therefore routine CT cannot be considered cost-effective in diagnosis of the cause of AAP (13). The present study of the group of patients with repeated assessments for diagnosis and need for the surgical therapy indicates that routine CT does increase the diagnostic accuracy in AAP. However, it does not reduce the number of hospital admissions, nor the length of the hospital stay. In this regard, it may not have an immediate effect on reducing costs. To conclude, the rather good diagnostic accuracy of routine CT in patients with AAP also improved surgeon’s confidence in their treatment decisions, but it was not able to reduce the use of hospital resources.

The strength of our study is that it was a prospective, randomized, controlled study design. Although the study groups were rather small, they were homogenous in terms of age and gender, and the relative frequencies of correct diagnoses were similar in both groups before randomization. We can assume that this study provides a representative cross-section of the use of abdominal CT in ED work-up.

Acknowledgements

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References


### Table II. Diagnostic accuracy of computed tomography (CT) and the change in the assessment of treatment.

<table>
<thead>
<tr>
<th></th>
<th>Routine CT (n=61)</th>
<th>Selective CT (n=32)</th>
<th>p-Valuea</th>
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<tr>
<td>Initial diagnosis</td>
<td></td>
<td></td>
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<tr>
<td>Correct: 31 (51.7)</td>
<td>Correct: 17 (53.1)</td>
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<td>0.833</td>
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<tr>
<td>Incorrect: 30 (48.3)</td>
<td>Incorrect: 15 (46.9)</td>
<td></td>
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<tr>
<td>Preoperative diagnosis</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Correct: 53 (86.9)</td>
<td>Correct: 22 (68.8)</td>
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<td></td>
</tr>
<tr>
<td>Incorrect: 8 (13.1)</td>
<td>Incorrect: 10 (31.2)</td>
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<td>0.035</td>
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<tr>
<td>Change in the assessment of the need for surgery</td>
<td>48 (78.7)</td>
<td>15 (46.9)</td>
<td>0.002</td>
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</tbody>
</table>

aData are number of cases (percentage). Significance within group: at b p<0.001 and c p=0.180.

<table>
<thead>
<tr>
<th></th>
<th>Odds ratio</th>
<th>p-Value</th>
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<tr>
<td>Preoperative diagnosis</td>
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<td></td>
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<tr>
<td>Routine CT group</td>
<td>4.046 (1.094-14.966)</td>
<td>0.036</td>
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<tr>
<td>Correct initial diagnosis</td>
<td>3.670 (1.087-12.389)</td>
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<td>Age group (&lt;65yrs)</td>
<td>3.457 (1.028-11.622)</td>
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<td>Change of assessment</td>
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<td>Routine CT group</td>
<td>4.469 (1.732-11.533)</td>
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</table>

Table III. The multiple logistic regression analysis of the independent parameters predicting the preoperative diagnosis and the change of the assessment of the need for surgery.


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