A Comparative Study of Results of Radiological and Cytological Tests

By

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It goes without saying that x-ray examination is of highest value in the diagnosis of gastric cancer in general. There are a number of complementary diagnostic methods next in importance to it and particularly, cytological diagnosis of gastric cancer has recently come to be evaluated very highly.1-26) The present authors have already published several reports on cytological diagnosis of gastric cancer by the gastric abrasive balloon method and described its superiority.21-29) In this paper, the results of cytological diagnosis is mentioned in comparison with the results of roentgenographical diagnosis.

EXPERIMENTAL

Material and Method

The majority of the subjects in this series were selected from in-patients and a smaller number of them from out-patients of this clinic with confirmed or suspected gastric cancer. A small number of patients with gastric ulcer and gastritis were studied as controls.

For collection techniques of cytological diagnosis, the gastric abrasive balloon was most frequently employed, but on very few occasions, gastric lavage with physiological saline or Ringer’s solution was employed.

For curtailing the time required for collecting cells and for facilitating the exfoliation of cells from foci giving a suspicion of malignancy, x-ray findings were for reference in cytological diagnosis, but for judgment of the findings, the cytological and roentgenographical findings were examined independently and separately.

Classification of Cytological Findings

Cytological findings are classified in this clinic on the basis of the
following schema after Papanicolaou:

Class I—Absence of atypical or abnormal cells.
Class II—Atypical cells present but no evidence of malignancy.
Class III—Cells present giving a suspicion of malignancy.
Class IV—Fairly conclusive evidence of a malignant neoplasm.
Class V—Conclusive evidence of a malignant neoplasm.

The findings of Class I and II are judged as negative, Class III as suspicious and Class IV and V as positive for cancer.

Classification of Roentgenographical Findings

X-ray pictures taken prior to the application of cytological tests alone were used in this connection. For facilitating comparison with the results of cytological diagnosis, roentgenographical findings are classified similarly into the following 5 classes:

Class I—Absence of atypical or abnormal findings.
Class II—Abnormal findings present but no evidence of malignancy (including the findings of gastritis, gastric ulcer and so on).
Class III—Findings present upon whom a malignant neoplasm or a malignant alteration of benign lesion is not completely excluded, or the presence of such malignant formation or alteration is rather suspicious.
Class IV—Fairly conclusive findings of a malignant neoplasm.
Class V—Conclusive findings of a malignant neoplasm, showing the typical findings belong to any of the 4 types of the roentgenographical classification of gastric cancer established at this clinic.*

The findings of Class I and II are judged as negative, Class III as suspicious and Class IV and V as positive for cancer.

* The roentgenographical classification of gastric cancer was succinctly furnished by Kurokawa. These are as follows:

Type I—Polypoid type of carcinoma protruding into the gastric lumen. A filling defect resembling the impression of a loophole or a window in the barium column arises from the mass. The roentgenographical type, therefore, is described as the “loophole form” or the “window form.”

Type II—Malignant ulcerative type of carcinoma. The roentgenographical sign is characterized with an ulcer niche on top of a filling defect from a heaped-up mass of neoplastic tissue protruding into the gastric lumen and seen face-on as a halo about the niche. The roentgenographical type is described as the “swimming tire form”, because the filling defect produced by this type of carcinoma resembles the impression of a swimming tire on the barium pool.

Type III—Infiltrating scirrhous type of carcinoma. This spreads diffusely through the gastric walls both superficially and deeply and leads
to extreme narrowing of the gastric lumen surrounded by the thick and rigid walls of the stomach. The roentgenographical type is described as the "iron pipe form" because of the thick and rigid walls resembling the impression of an iron pipe.

Type IV—Mixed type of carcinoma. This represents a mixture of above three types of carcinoma and therefore, the roentgenographical appearance shows a combined of the above three forms, that is a "mixed form". It also often shows the "honey comb form" resembling the impression of a honey comb.

Results

I. Over-all results of cytological diagnosis

Of the 831 patients studied by the end of November, 1958, gastric cancer was proved at operation or autopsy or was diagnosed as positive for cancer on the basis of definite clinical findings in 303. The remaining 528 were patients with other benign diagnosis.

The over-all results shown in Table I indicate that in the cancer group 90.4 per cent were correctly reported as cytologically positive or suspicious, 9.6 per cent failed to exhibit cells suspicious or positive for cancer. In the non-cancerous group 97.2 per cent were correctly interpreted as negative but 2.8 per cent were incorrectly read as suspicious or positive for cancer.

II. Comparison of results: cytological diagnosis vs. radiological diagnosis

A comparative study of the results of cytological and radiological diagnoses was conducted in 228 of the 303 cancerous cases and in 461 of
TABLE II
Comparison of Results: X-Ray Diagnosis vs. Cytological Diagnosis in the 228 Cancerous Cases and the 461 Non-cancerous Cases

<table>
<thead>
<tr>
<th></th>
<th>X-ray diagnosis</th>
<th>Cytological diagnosis</th>
<th>Combined application*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cancer 228 cases</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of cases</td>
<td>2 32 194</td>
<td>24 9 195</td>
<td>2 10 216</td>
</tr>
<tr>
<td>%</td>
<td>0.9% 14.0% 85.1%</td>
<td>10.5% 4.0% 85.5%</td>
<td>0.9% 4.4% 94.7%</td>
</tr>
<tr>
<td>No cancer 461 cases</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of cases</td>
<td>253 190 18</td>
<td>447 5 9</td>
<td>449 7 5</td>
</tr>
<tr>
<td>%</td>
<td>54.9% 41.2% 3.9%</td>
<td>97.0% 1.0% 2.0%</td>
<td>97.4% 1.6% 1.1%</td>
</tr>
</tbody>
</table>

* Diagnosis by combined application of x-ray and cytological examinations.

Negat.——Negative  Susp.——Suspicious  Posit.——Positive

the 528 non-cancerous cases, or in 689 cases in total.

1. Comparison of over-all results (Table II)

In the 228 cancerous cases, the over-all results shown in Table II indicated that the accuracy of positive or suspicious diagnosis by radiological examination (99.1 per cent) is higher than that by cytological examination, but the accuracy of positive diagnosis (excluding suspicious diagnoses) is the approximate equal value of 85 per cent with both methods. The rate of suspicious diagnoses was much higher in radiological examination (14.0 per cent) than in cytological examination (4.0 per cent). When both methods of study were used in combination, the accuracy of positive diagnosis (94.7 per cent) rose higher than by single application of any of these diagnostic methods.

In the 461 non-cancerous cases, the accuracy of cytological diagnosis (97.0 per cent) was much higher than that of radiological diagnosis (54.9 per cent). A much higher percentage (45.1 per cent) of suspicious (41.2 per cent) or positive reports (3.9 per cent) was obtained by radiological examination, while by cytological examination a much smaller percentage (3.0 per cent) of such incorrect reports was obtained. By a combined application of both methods the accuracy of correct diagnosis could be raised to 97.4 per cent.

2. Comparison of results by location of lesions (Tables III and IV)

In the neoplasms of the cardia-fornix the cytological and radiological tests, both achieved success in 100 per cent (including suspicious diagnosis) and in those of the corpus the accuracy of positive or suspicious diagnosis was much better with radiological examination (98.1 per cent) than with
### Table III
Comparison of Results by Location of Neoplasms: X-Ray Diagnosis vs. Cytological Diagnosis in 59 Cases with the Neoplasm of the Cardia-Fornix, 108 Cases with the Neoplasm of the Corpus and 61 Cases with the Neoplasm of the Antrum-Pylorus

<table>
<thead>
<tr>
<th></th>
<th>X-ray diagnosis</th>
<th>Cytological diagnosis</th>
<th>Combined application*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardia-fornix 59 cases</td>
<td>0%</td>
<td>11%</td>
<td>48%</td>
</tr>
<tr>
<td>Corpus 108 cases</td>
<td>2%</td>
<td>15%</td>
<td>91%</td>
</tr>
<tr>
<td>Antrum-pylorus 61 cases</td>
<td>0%</td>
<td>6%</td>
<td>55%</td>
</tr>
</tbody>
</table>

* Diagnosis by a combined application of x-ray and cytological examinations.

### Table IV
Comparison of Results by Location of Lesions: X-Ray Diagnosis vs. Cytological Diagnosis in the 113 Cases of the Cardia-Fornix, the 242 Cases of the Corpus and the 106 Cases of the Antrum-Pylorus, in Total 461 Cases without Cancer

<table>
<thead>
<tr>
<th></th>
<th>X-ray diagnosis</th>
<th>Cytological diagnosis</th>
<th>Combined application*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardia-fornix 113 cases</td>
<td>52%</td>
<td>57%</td>
<td>4%</td>
</tr>
<tr>
<td>Corpus 242 cases</td>
<td>144%</td>
<td>90%</td>
<td>8%</td>
</tr>
<tr>
<td>Antrum-pylorus 106 cases</td>
<td>57%</td>
<td>43%</td>
<td>6%</td>
</tr>
</tbody>
</table>

* Diagnosis by a combined application of x-ray and cytological examinations.
cytological examination (88.9 per cent). When neoplasms were located in the antrum-pylorus, radiological examination bore 100 per cent successful reports, but the accuracy of cytological diagnosis was rather low (80.3 per cent). The accuracy of positive diagnosis (excluding suspicious diagnosis) was higher with cytological diagnosis (100 per cent) than with radiological diagnosis (81.4 per cent) in the neoplasms of the cardia-fornix, and in those of the corpus was equal with both radiological and cytological diagnoses (84.3 per cent). While in the neoplasms of the antrum-pylorus the accuracy of positive diagnosis was higher with radiological examination (90.2 per cent) than with cytological examination (73.8 per cent) and the high accuracy of positive diagnosis (96.7 per cent) was obtained with a combined application of both methods.

In the next place, the neoplasms of 22 cases could not be confirmed by radiological examination but cytological examination. One of them with neoplasm of the cardia-fornix showed negative findings upon radiological examination, while the remaining 11 cases with neoplasms of the cardia-fornix, 8 cases of the corpus and 2 cases of the antrum-pylorus showed suspicious findings in their roentgenograms, but positive findings upon cytological tests. Such neoplasms of discrepant results were more frequent among the neoplasms of the cardia-fornix more difficult to detect roentgenographically.

In the non-cancerous cases, the accuracy of radiological diagnosis was a half of cases wherever the suspected lesions of the stomach are located, while the accuracy of cytological diagnosis was more than 95 per cent of the cases.

3. Comparison of results in the cases with intramucosal carcinoma

Six intramucosal carcinomas were histologically proved in the stomach which had undergone a gastric resection. All of these carcinomas showed positive findings radiologically, while five among them were correctly reported as cytologically positive, but another failed to exhibit cells either suspicious or positive because of the small tumor scarcely cropping out on the surface of the mucous membrane.

4. The relation between roentgenographical types of neoplasms and results of cytological diagnosis (Table V)

Roentgenographical types of gastric cancer were divided into four, according to the roentgenographical classification by Kurokawa, as mentioned already, and the results were studied in relation with results of cytological diagnosis.

The accuracy of cytological diagnosis was 91 per cent in the neoplasms of Types I, III and IV and 84.3 per cent in those of Type II. In the neoplasms of the cardia-fornix, the accuracy was rather low in Type III than in Type I, II, and IV, in the neoplasms of the corpus, the highest
in Type I and lower in Types III, IV and II in the order named, and in those of the antrum-pylorus, the highest in Type IV followed by Types III, II and I in descending order.

5. Comparison of results in the cases with ulcerating lesions of the stomach (Table VI)

There were the 88 cases with malignant ulcer, that is, the 12 cases with cancer-ulcer and the 76 cases with cancerous ulcer, and the 168 cases with benign gastric ulcer.

The accuracy of positive diagnosis in the 88 malignant ulcers of the stomach was 84.1 per cent with radiological examination, 81.8 per cent with cytological examination and 91.0 per cent with combined application of both methods respectively.

In the 12 ulcer-cancers of the malignant ulcers, the accuracy of positive or suspicious diagnosis was 83.3 per cent with radiological examination and 66.7 per cent with cytological examination, but if the suspicious diagnoses are excluded, the accuracy falls to the low level of 50.0 per cent with radiological and 41.7 per cent with cytological examinations, not rising beyond 66.7 per cent even with combined application of both methods. If the suspicious diagnoses are included, the accuracy was rather high (91.7 per cent) with combined application of both methods.

In the 76 cancerous ulcer, the accuracy of positive diagnosis was rather high with any of these diagnostic methods, particularly with combined application of both methods (96.1 per cent).

In the 168 benign gastric ulcers, the rate of suspicious or false-positive diagnoses was 40.5 per cent with radiological and 4.2 per cent with cyto-

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**Table V**

The Relation between Roentgenographical Types of Neoplasms (by Kurokawa's Classification) and Cytological Test Results

<table>
<thead>
<tr>
<th>Roentgenographical classification of gastric cancer by Kurokawa</th>
<th>Cardia-fornix</th>
<th>Corpus</th>
<th>Antrum-pylorus</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type I (loophole form)</td>
<td>6</td>
<td>6</td>
<td>100.0%</td>
<td>11</td>
</tr>
<tr>
<td>Type II (swimming form)</td>
<td>32</td>
<td>32</td>
<td>100.0%</td>
<td>59</td>
</tr>
<tr>
<td>Type III (iron pipe form)</td>
<td>19</td>
<td>18</td>
<td>94.7%</td>
<td>26</td>
</tr>
<tr>
<td>Type IV (mixed form)</td>
<td>12</td>
<td>12</td>
<td>100.0%</td>
<td>47</td>
</tr>
</tbody>
</table>

Num.—Number of cases.
Pos.—Number of cases with positive report.
Accur.—Accuracy of positive diagnosis.
Comparison of Results in Cases with Ulcerating Lesions: X-Ray Diagnosis vs. Cytological Diagnosis in the 88 Cases with Malignant Ulcer and the 168 Cases with Benign Ulcer

<table>
<thead>
<tr>
<th></th>
<th>Number of cases</th>
<th>X-ray diagnosis</th>
<th>Cytological diagnosis</th>
<th>Combined application*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td>88</td>
<td>11</td>
<td>74</td>
<td>3</td>
</tr>
<tr>
<td><strong>Ulcer-cancer</strong></td>
<td>12</td>
<td>4</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td><strong>Cancerous ulcer</strong></td>
<td>76</td>
<td>6</td>
<td>68</td>
<td>1.3%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>168</td>
<td>62</td>
<td>6</td>
<td>100</td>
</tr>
<tr>
<td><strong>Benign ulcer</strong></td>
<td></td>
<td>8</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td><strong>Callous ulcer</strong></td>
<td>14</td>
<td>5</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td><strong>Non-callous ulcer</strong></td>
<td>154</td>
<td>57</td>
<td>5</td>
<td>149</td>
</tr>
</tbody>
</table>

* Diagnosis by a combined application of x-ray and cytological examinations.
Negat.—Negative  Susp.—Suspicious  Posit.—Positive

logical examinations respectively, but if the suspicious diagnoses are excluded, the rate of incorrect diagnoses is reduced to less than 4 per cent. Thus, suspicious diagnosis being rather frequent with radiological examination and being rare with cytological examination respectively, a combined application of these two methods will surely enhance the accuracy of diagnosis to a extremely high level.

When the benign gastric ulcers are divided into the callous and non-callous ulcers, the rate of incorrect diagnoses is higher by many folds in the callous ulcers than in the non-callous ulcers with any of the diagnostic methods. Particularly, the high rate of incorrect diagnoses (14.3 per cent) upon cytological tests in the callous ulcers should be noted.

6. Comparison of results in the cases with benign polyp or polyposis, malignant polyp, gastritis and other benign diseases (Table VII).
TABLE VII

Comparison of Results: X-Ray Diagnosis vs. Cytological Diagnosis in the 17 Cases with Benign Polyp or Polyposis, the 4 Cases with Malignant Polyp, the 217 Cases with Gastritis and the 59 Cases with other Benign Diseases

<table>
<thead>
<tr>
<th></th>
<th>Number of cases</th>
<th>X-ray diagnosis</th>
<th>Cytological diagnosis</th>
<th>Combined application*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benign polyp and polyposis</td>
<td>17</td>
<td>9</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>52.9%</td>
<td>35.3%</td>
<td>11.8%</td>
</tr>
<tr>
<td>Malignant polyp</td>
<td>4</td>
<td>0</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0%</td>
<td>25.0%</td>
<td>75.0%</td>
</tr>
<tr>
<td>Gastritis</td>
<td>217</td>
<td>104</td>
<td>106</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>47.9%</td>
<td>48.9%</td>
<td>3.2%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>52.1%</td>
<td>1.8%</td>
<td>1.8%</td>
</tr>
<tr>
<td>Others</td>
<td>59</td>
<td>40</td>
<td>16</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>67.8%</td>
<td>27.1%</td>
<td>5.1%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>32.2%</td>
<td>72.9%</td>
<td>4.9%</td>
</tr>
</tbody>
</table>

* Diagnosis by a combined application of x-ray and cytological examinations.

Negat.—Negative  Susp.—Suspicious  Posit.—Positive

In the 17 benign polyp or polyposis of the stomach, the results showed similar tendencies as observed the benign gastric ulcers.

In the 4 polyps with malignant alteration into carcinoma, the accuracy of diagnosis was 75 per cent with either radiological or cytological examination, but upon combined application of both methods, the accuracy attained 100 per cent of the cases.

In the cases with gastritis or other benign diseases of the stomach, the tendencies of the results was the same as in the cases with benign gastric ulcer.

CONCLUSIONS

Experience with gastric cytologic study in 831 patients has been reviewed, and particularly, comparisons have been made between the accuracy of radiological and cytological diagnoses in 689 of these patients.

It goes without saying that radiological examination is indispensable in the diagnosis of the pathologic conditions of the stomach, especially, gastric cancer and the accuracy of correct diagnosis obtained thereby is high.
Radiological and cytological diagnoses are almost equally reliable in reporting malignant disease of the stomach in this series. The overlapping, combined accuracy of these two methods, however, appreciably increases the accuracy of this diagnosis in the doubtful or indeterminate group of pathologic conditions in the stomach. Cytological study should therefore be used in conjunction with and not in competition with radiological study of these difficult cases. Although disclosure of tumor cells is almost always confirmatory of gastric malignancy and absence of tumor cells suggests a benign lesion, failure to identify tumor cells does not rule out malignancy. Besides, cytological examination does not furnish data for diagnosing gastric ulcer, gastric polyp, gastritis and other benign gastric lesions. In addition, gastric cytologic analysis is powerless in giving informations on the location, the extent or size of neoplasms or the indication of surgical operation. These informations must be sought by radiological examination which also gives a clue to more appropriate application of cytological examination.

In summary, the adjunctive or complementary rather than competitive approach in the application of cytology and radiography is emphasized.

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