Clinical Evaluation of Thyroid Imaging with $^{201}$Tl-Chloride

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Clinical value and limitation of thyroid imaging with $^{201}$TlCl were studied. The positive rate of $^{201}$Tl was 82% in 22 malignant thyroid lesions and 46% in 37 benign lesions. A $^{201}$Tl positive image was obtained when a lesion was parenchymatous and a $^{201}$Tl negative one when it was cystic, filled with colloid or hyaline and had massive necrosis or bleeding. Thus $^{201}$Tl Cl localized in a parenchymatous lesion and did not in a nonparenchymatous one regardless of a malignant or benign disease. An increasing positive lesion in contrast with the surrounding thyroid tissue implies that it may be malignant and a decreasing one benign as a results of review of serial scintiphotos. Scintigraphic methods with $^{131}$I and $^{201}$Tl are complementary each other and a $^{201}$Tl negative image itself has a high diagnostic value but it seems to be better to attach much value to the finding of imaging with $^{131}$I when a $^{201}$Tl positive image is obtained.

Key Words: thyroid imaging, thallium-201 chloride, positive rate, positive image, parenchymatous lesion, negative image, nonparenchymatous lesion, sodium iodide-131

1. Introduction

A cold nodule on the scintigram obtained by thyroid imaging with $^{131}$I is essentially a non-specific finding. In 1976 $^{201}$Tl-chloride, the myocardial imaging agent$^{11,12}$, was found to have the property of localizing in thyroid cancers by Tonami, et al.$^{13}$ Since Jan. 1977 we have used this agent for thyroid scintigraphy in expectation of its use being able to differentiate benign from malignant thyroid lesions. In this paper, the rate of $^{201}$Tl accumulation in $^{131}$I cold nodules of various thyroid diseases, comparison of $^{201}$Tl images with their pathological findings, changes of $^{201}$Tl concentration in the lesions with the lapse of time after its injection and combined scintigraphic diagnosis with $^{131}$I and $^{201}$Tl are studied and the usefulness and limitation of thyroid imaging with $^{201}$Tl are estimated and discussed.

2. Materials and Methods

The patients in whom imaging with $^{131}$I had been performed were administered 800 µCi—2 mCi of $^{201}$TlCl intravenously with which provided us by Daiichi Radioisotopes Labs., LTD. Thyroid images were taken serially at 5, 15, 30 and 60 minutes in principle after its injection using mercury K-X rays of 69-83 keV with a preset count of 17 k per exposure when using a pin-hole collimator and 100 k when using a low energy multiparallel collimator. The scinticamera used is RC-1C-1205, HITACHI, Japan. Fifty one patients undergoing thyroid imaging with $^{131}$I and $^{201}$Tl were subjects for this study. Of these patients, nineteen had malignant strumas, one had a malignant struma and an adenomata, nineteen had adenomas, five had adenomatous goiters, four had chronic thyroiditis and three had metastatic cervical tumors. In every case, the pathological diagnosis was made by operation or biopsy. The judgement of $^{201}$Tl accumulation in the lesion which showed a cold nodule on the $^{131}$I scintigram was made as follows: The degree of deposit in the lesion was lower than that in the surrounding thyroid tissue on every scintigram, negative (−); was the same as it, positive (+); and was higher than it, highly positive (++) on at least one of the several scintigrams obtained serially.

3. Results

3.1 Positive rate of $^{201}$Tl in various thyroid diseases

Table 1 shows the results of 20 cases of
Table 1 Positive rate and degree of deposit of $^{201}$Tl for 22 malignant thyroid lesions

<table>
<thead>
<tr>
<th>Pathological diagnosis</th>
<th>No. of cases</th>
<th>Deposit of $^{201}$Tl</th>
<th>Positive rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Papillary adenocarcinoma</td>
<td>6</td>
<td>3</td>
<td>57 (4/7)</td>
</tr>
<tr>
<td>Well differentiated papillary adenocarcinoma</td>
<td>3</td>
<td>0</td>
<td>100 (3/3)</td>
</tr>
<tr>
<td>Follicular adenocarcinoma</td>
<td>4</td>
<td>0</td>
<td>100 (4/4)</td>
</tr>
<tr>
<td>Mixed type papillary and follicular adenocarcinoma</td>
<td>1</td>
<td>0</td>
<td>100 (1/1)</td>
</tr>
<tr>
<td>Undifferentiated carcinoma</td>
<td>2</td>
<td>0</td>
<td>100 (2/2)</td>
</tr>
<tr>
<td>Malignant lymphoma</td>
<td>3</td>
<td>1</td>
<td>75 (3/4)</td>
</tr>
<tr>
<td>Metastatic squamous cell carcinoma</td>
<td>1</td>
<td>0</td>
<td>100 (1/1)</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>4</td>
<td>82 (18/22)</td>
</tr>
</tbody>
</table>

malignant struma (22 lesions are due to that each $^{131}$I cold nodule of 2 cases consisted of a positive and a negative site). In malignant thyroid lesions, the overall positive rate of $^{201}$Tl was 82% (18/22). Of 4 highly positive lesions, 2 showed well differentiated papillary adenocarcinoma. Table 2 shows the results of benign thyroid diseases. In adenomata, the positive rate of $^{201}$Tl was 33% (8/22), in adenomatous goiters, 50% (4/8) and in chronic thyroiditis, 100% (5/5). The overall positive rate of $^{201}$Tl in benign lesions was 46% (17/37). And 3 metastatic cervical lesions of 2 cases of postoperative thyroid cancer (papillary adenocarcinoma) showed all clear positive images but one metastatic cervical lesion of a case of squamous cell carcinoma was not visualized in spite of the tumor sized of a man’s fist and one lesion of another case showed a faint positive image.

Table 2 Positive rate and degree of deposit of $^{201}$Tl for 37 benign thyroid lesions

<table>
<thead>
<tr>
<th>Pathological diagnosis</th>
<th>No. of cases</th>
<th>Deposit of $^{201}$Tl</th>
<th>Positive rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adenoma</td>
<td>19</td>
<td>15</td>
<td>33 (8/24)</td>
</tr>
<tr>
<td>Papillary</td>
<td>1</td>
<td>1</td>
<td>100 (5/5)</td>
</tr>
<tr>
<td>Adenomatous goiter</td>
<td>5</td>
<td>4</td>
<td>50 (4/8)</td>
</tr>
<tr>
<td>Chronic thyroiditis</td>
<td>4</td>
<td>0</td>
<td>100 (5/5)</td>
</tr>
<tr>
<td>Total</td>
<td>29</td>
<td>20</td>
<td>46 (17/37)</td>
</tr>
</tbody>
</table>

lesions by the positive image only, the positive and negative lesions were compared with their pathological findings. All 19 malignant positive lesions (one is a metastatic cervical site) were parenchymatous, 3 malignant negative lesions formed cysts and another one had massive necrosis. Of all 12 benign positive lesions, 11 were parenchymatous and one formed a cyst in which many nodules existed. Of all 20 benign negative lesions, 12 formed cysts, 2 had cysts filled with colloid or hyaline, 3 were filled with colloid and other 3 had massive necrosis or bleeding. Thus it is obvious that $^{201}$TlCl localizes in a parenchymatous but does not in a nonparenchymatous lesion regardless of a malignant or benign disease. Here are presented the scintigrams of illustrative cases (Fig. 1 and 2).

3.2 Comparison of positive and negative lesions of $^{201}$Tl with their pathological findings

As the results mentioned above means it is difficult to differentiate benign from malignant

3.3 Serial changes of positive lesions of $^{201}$Tl Degree of deposit of the positive lesion com-

Fig. 1 A 41-year-old man with papillary adenocarcinoma of thyroid.

The $^{131}$I scintigram (a) shows almost complete defect of the left lobe and $^{201}$Tl localized in its lower portion which was parenchymatous but did not in its upper region which showed cystic degeneration (b).
Fig. 2 A 77-year-old man with follicular adenoma of thyroid. A cold nodule of each lobe is shown on the image with $^{131}$I (a). $^{201}$Tl localized in the parenchymatous adenoma of right lobe and did not in the cystic one of left lobe (b).

Fig. 3 A 69-year-old man with malignant lymphoma of thyroid. An irregular cold area of right lobe is seen on the $^{131}$I-scinti-photo (a). The relative concentration of $^{201}$Tl in the lesion is increasing on the 90-minute-image (c), in comparison with that on the 5-minute-image (b).

Fig. 4 A 48-year-old woman with follicular adenoma of thyroid. A $^{131}$I cold nodule of right lobe (a) showed a highly positive finding on the 5-minute-image with $^{201}$Tl (b) but its radioactivity was decreasing relatively on the 60-minute-image (c).

The overall diagnostic reliability of thyroid scintigraphy with $^{131}$I is 75% (42/56). When the cold nodules showed $^{201}$Tl negative images, 19 (90%) of 21 lesions were benign, but the diagnostic reliability of thyroid scintigraphy with $^{131}$I was 67% (14/21). When the cold nodules showed positive findings, 18 lesions (51%) were malignant and 17 (49%) were benign, but the diagnostic reliability with $^{131}$I was 80% (28/35). These results lead us to a conception that if a cold nodule is given a negative finding by thyroid imaging with $^{201}$Tl, it strongly suggests a benign lesion but if a positive finding, we had better lay the more diagnostic value upon thyroid scintigraphic finding with $^{131}$I.

4. Discussion

In 1976 Cox, et al. and Tomami, et al. found clinically...
Table 3 Comparison of thyroid imagings with $^{131}$I and $^{201}$Tl with the established diagnosis

<table>
<thead>
<tr>
<th>Diagnosis of cold nodules with $^{131}$I</th>
<th>Findings of $^{201}$Tl</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Negative</td>
</tr>
<tr>
<td></td>
<td>Malignant</td>
</tr>
<tr>
<td>Malignant lesions suspected</td>
<td>1</td>
</tr>
<tr>
<td>Benign lesions suspected</td>
<td>1</td>
</tr>
</tbody>
</table>

and reported that $^{201}$Tl-chloride which has been used as a myocardial imaging agent had the affinity to malignant tumors. Especially the latter noticed concentrating of this agent in the $^{131}$I cold nodules of all 7 cases of thyroid cancer and the possibility was suggested of the differentiation of benign from malignant thyroid diseases. Subsequently several reports concerning thyroid scintigraphy with $^{201}$Tl have been seen and its clinical diagnostic value seems to be coming to a conclusion. A positive image with $^{201}$Tl in a $^{131}$I cold nodule means the lesion is parenchymatous and a negative one does it is such a nonparenchymatous lesion as a cyst, filled with colloid or hyaline and shows necrosis or bleeding. Therefore the degree of deposit of $^{201}$Tl may depend on the amount of parenchyma in a thyroidal lesion and it is difficult to differentiate a benign from malignant lesion by the positive image only. But when the negative image is obtained, it is very useful to make a diagnosis of a benign nonparenchymatous lesion, for example, 19 (90%) of 21 cold nodules that showed negative images with $^{201}$Tl were benign lesions in our study. But as imaging with $^{201}$Tl showed a negative finding in 2 cases of malignant cystic struma whose margin only was carcinomatous, it has the diagnostic limitation to such a malignant cystic lesion. Although the image of normal thyroid gland could be gained by imaging immediately after injection of $^{201}$Tl, its uptake in thyroid lesions seemed to be varied according to cases. The localization of $^{201}$Tl in a lesion was obscure on the 5-minute-image but came to be clear on the 20-30-minute-image in 4 cases (each one case of undifferentiated carcinoma, metastatic squamous cell carcinoma, malignant lymphoma and follicular adenoma) and 13 of 35 positive lesions of $^{201}$Tl showed relative change of deposit in contrast with the surrounding thyroid tissue on serial scintiphotos. These findings are interesting because the mechanism of localization of $^{201}$Tl may be different between normal thyroid and thyroid lesions or between thyroid lesions themselves and may be taken part in by not one factor such as blood flow but several factors. From clinical aspect, observation of serial changes of positive lesions with the lapse of time may contribute to the differentiation of benign from malignant lesions. Therefore it is preferable to take several scintiphotos within about one hour after injection of $^{201}$Tl.

As metastatic cervical lesions of thyroid cancer could be detected as clear positive images like other authors reported, but those of squamous cell carcinoma were visualised faintly or not visualized, there is the possibility that $^{201}$Tl uptake in metastatic cervical lesions may be different according to the origin or the histological types of cancer.

5. Conclusion

Thyroid imagings with $^{131}$I and $^{201}$Tl were performed in the patients with various thyroid diseases and cervical tumors to evaluate the value of $^{201}$TlC1 for thyroid scintigraphy and its clinical usefulness and limitation were reviewed and discussed.

1) $^{201}$TlC1 localized in parenchymatous lesions of thyroid and did not in such nonparenchymatous lesions as cysts, filled with colloid or hyaline and showed massive necrosis or bleeding.

2) The positive image only with $^{201}$Tl is not a characteristic finding of a benign or malignant thyroid lesion but the negative image strongly suggests a benign disease.

3) The increasing positive lesion of $^{201}$Tl in contrast with the surrounding thyroid tissue implies that it may be malignant and the decreasing one benign.

4) Thyroid imagings with $^{131}$I and $^{201}$Tl are complementary each other and the negative image with $^{201}$Tl itself has the high diagnostic value but it seems to be better to attach much
value to the finding of thyroid scintigraphy with 131I when a positive image is obtained.

Acknowledgment

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References


要 旨

201Tl-Chloride による甲状腺イメージングの臨床的評価

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201TlCl による甲状腺イメージングの臨床的価値と限界が検討された。22悪性甲状腺病変の 201Tl の陽性率は 82%で、37良性病変では 46%であった。201Tl の陽性像は病変部が実質性の場合に、陰性像はのう腫状の場合やコロイド型 tapiRNAで充満されている場合、壊死や出血が広範な場合に得られた。従って 201Tl は悪性・良性を問わず、実質病変の場合は集積し、非実質病変の場合は集積しなかった。経時に得られたシンチフォトの検討の結果、周囲甲状腺組織に比し、増強する陰性病変は悪性の、低下するものは良性の可能性が示唆された。201Tl の陰性像は高い診断価値があるが、陽性像の場合は 131I のイメージング所見に重きを置いたほうがよいと思われる。