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多次元ﾃﾞｼﾞﾀﾙ映像の認識と可視化に基づく自動診断ｼｽﾃﾑの開発に関する研究
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分担課題名：

がん診断支援ｼｽﾃﾑの評価と医師の読影機能の分析に関する研究

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４．ＣＲＴモニターによるＣＴ画像読影の視線解析―実験システムの開発と診断精度評価への応用
松本　徹（放医研）

CARS 2001 – H.U. Lemke, M.W. Vannier, K. Inamura, A.G. Farman & K. Doi (Editors)
2001 Elsevier Science B.V.

Observer Performance Study for CT-Image Reading of One Slice or Multislice by the Cine Display Mode of CRT System –An Application of the Diagnostic-Dynamic Characteristic (DDC) Model

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1. INTRODUCTION

A decision-making in a medical image reading is influenced by various psychological factors. We proposed the diagnostic-dynamic characteristic model (DDC), which describes a relation between the confidence level of abnormality and the search time on an image [1]. In this study, we undertook to apply the DDC model for the CT-image reading and to evaluate the observer performance by ROC analysis with data derived from the DDC model.

2. THE DDC MODEL

Generally, when physicians read an image and decide a "abnormal" or "normal" or "intermediate" confidence level($0 \leqq p \leqq 1$), they requires some time(t) for searching an image. In this model it is supposed that the time required for searching an image depends on several factors of image quality and skill of reader (k), facilitation of diagnosis of an image[$c \equiv 2p^*/[p^*(1-p^*)]; p^*=p(t\rightarrow\infty)$], and preconception $S=p(0)$ before image reading.
$p(t)=[-e^2(1-f)+2ecS(1+f)-2gcS(1-f)+g^2(1-f)]/[2ec(1+f)-4c^2S(1-f)+2gc(1-f)]$, where,
$e=\sqrt{(c^2+4)}$, $f=\exp(ekt)$, $g=c-2$, and $0 \leqq S \leqq 1$ is the value arbitrarily selected.

3. EXPERIMENTS AND RESULTS

To demonstrate the hypothesis derived from the DDC model, CT-image-reading studies by the cine mode display of CRT system were executed. Subjects answered either the "abnormal" or "normal" for the CT image and reported the regions (x,y,z) of abnormal finding. Eye movement data were collected and the time taken for searching any abnormal or normal region were measured as the function of each CT image (x-y) at each slice position(z). The confidence level p(t) was continuously estimated from the DDC model by using the eye fixation time as a function of the eye-position data(x,y,z) and the ROC curve was constructed with the estimated confidence level p(t). The ROC curve made from ordinal scores of equal interval by four steps was compared with an ROC curve obtained by continuously distributed probability (p) derived from the DDC model. Both ROC curves were approximately identical.

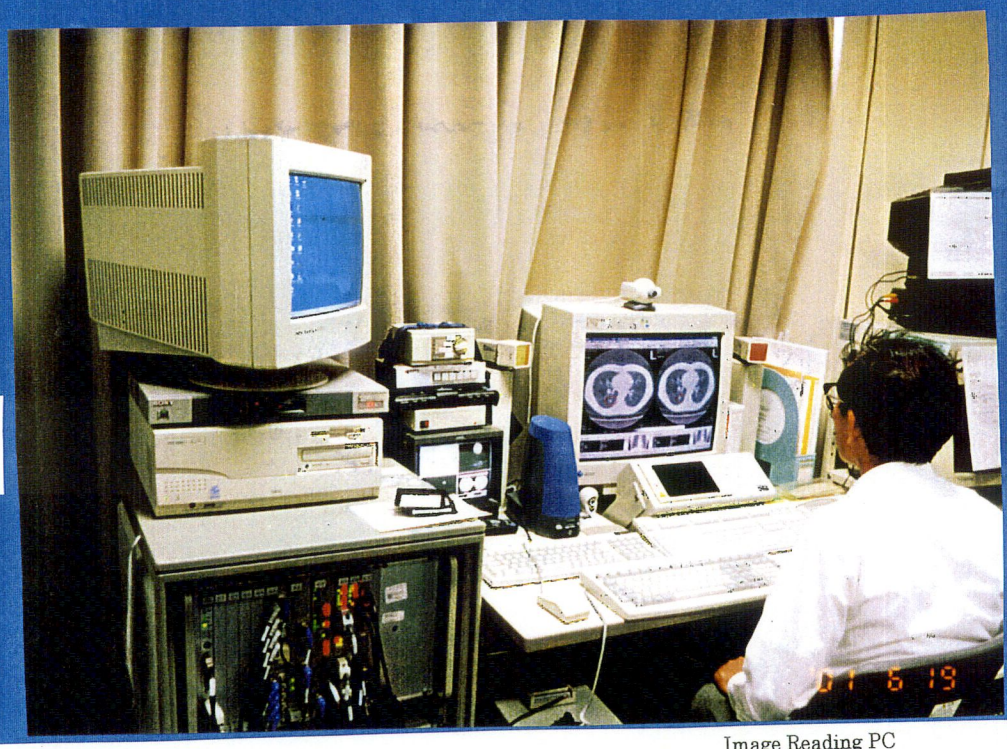
4. CONCLUSION

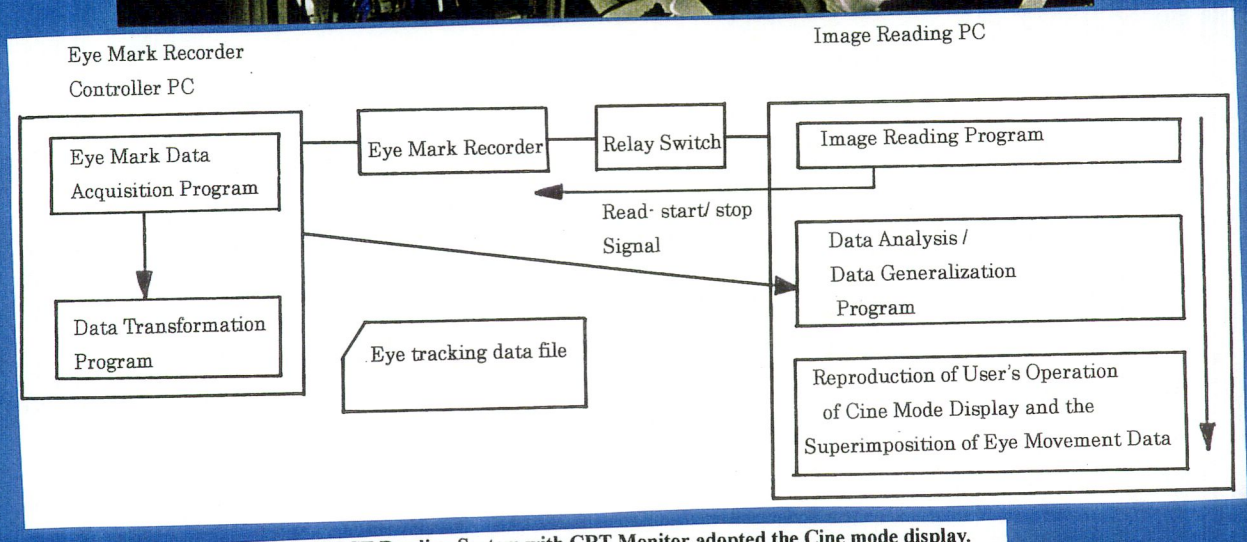
If a search time is measured for each image observation and the DDC model is applied, although a judgment of subject is zero or one ("abnormal" or "normal"), we can compose the ROC curve by using continuously distributed probability of the DDC model as a function of the image position (x,y,z).

REFERENCES

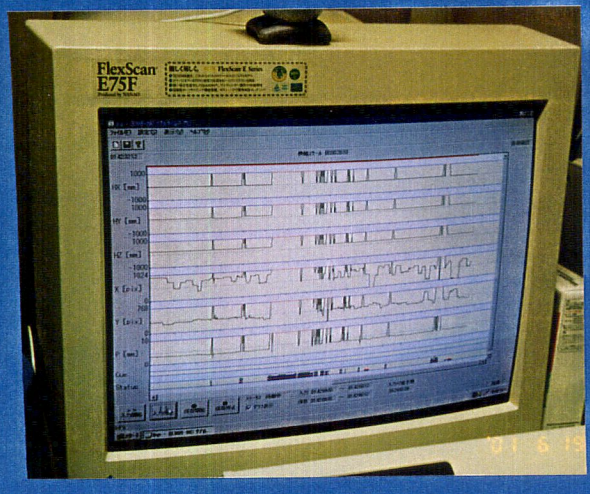
[1]: T. Matsumoto et al.: CARS 2000 – 2000 Elsevier Science B.V. 1051

Fig.1



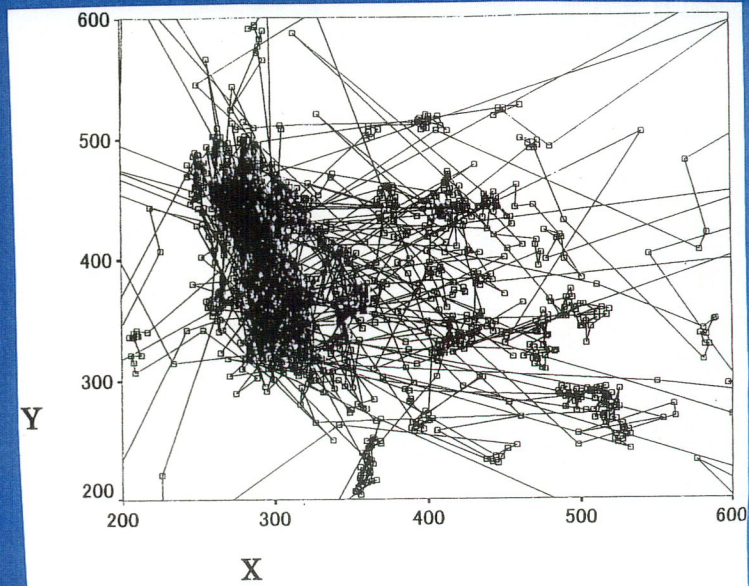


Development of CT Reading System with CRT Monitor adopted the Cine mode display. The System has several functions as follows; Recording of Reading Operation Data, Acquisition of Eye movement Data and Reappearance of Those Data



Monitoring of Eye Movement

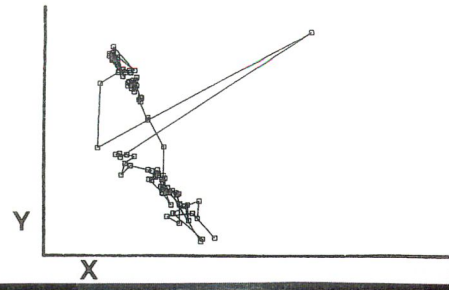
(x,y, p; pupil size)

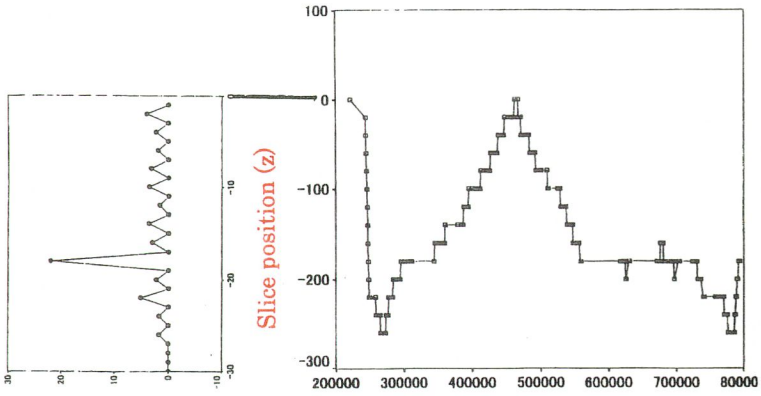


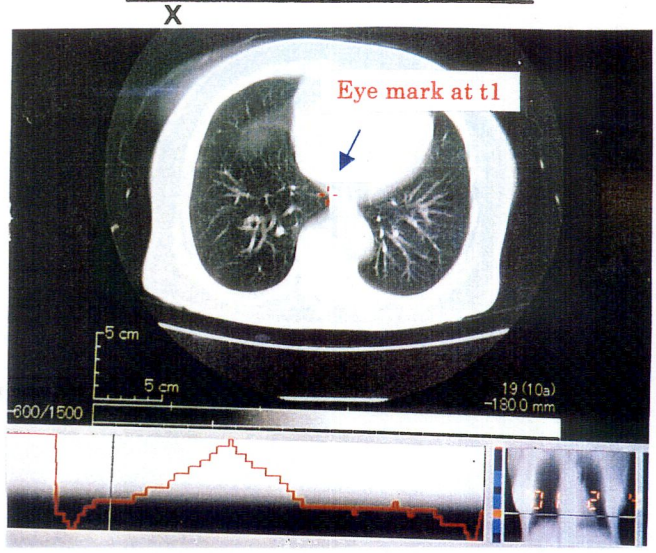
Eye tracking data among whole observation time obtained by image reading with the cine display mode

Fig.2 Our experimental system and results of collected eye movement data

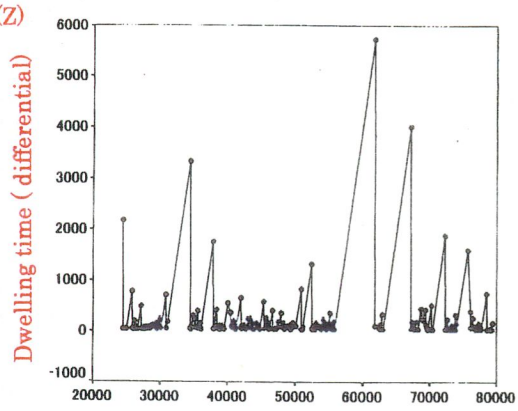
Eye tracking data at the slice position(z) about t2



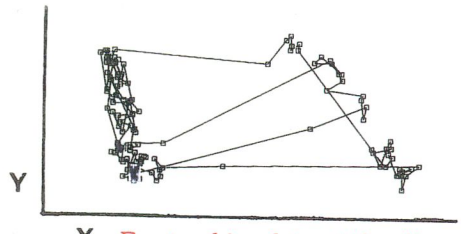




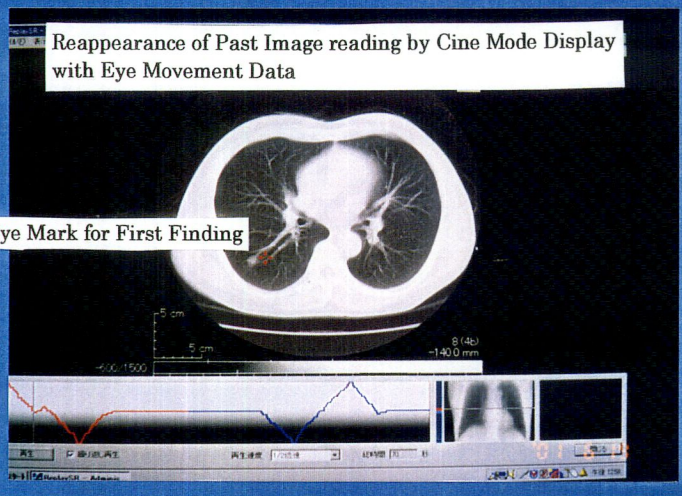
Dwelling time / slice position(Z)

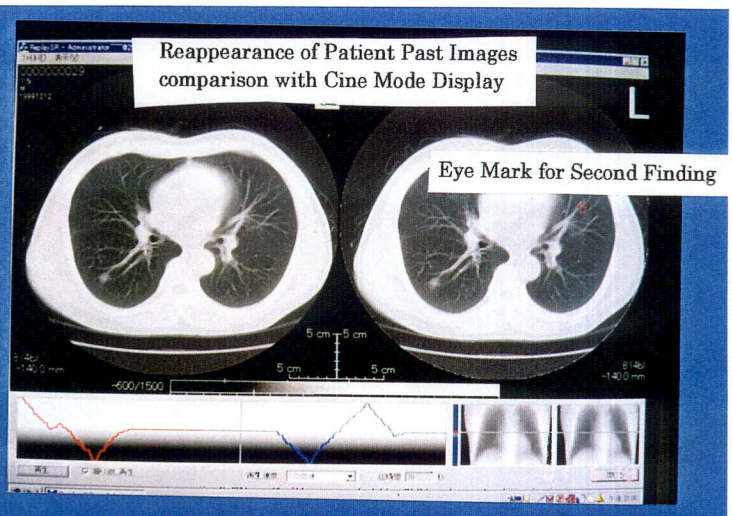


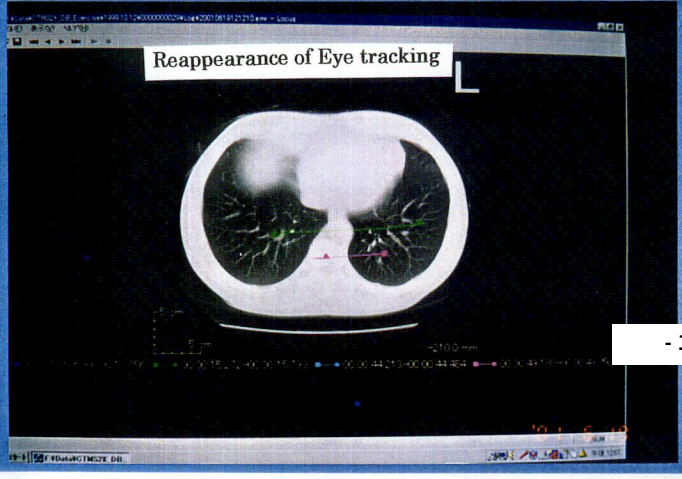
(t1) Observation time (t) (t2)

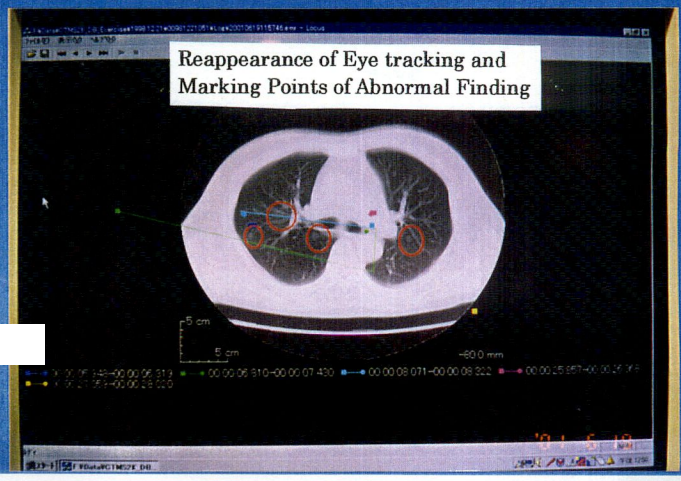


Eye tracking data at the slice position(z) about









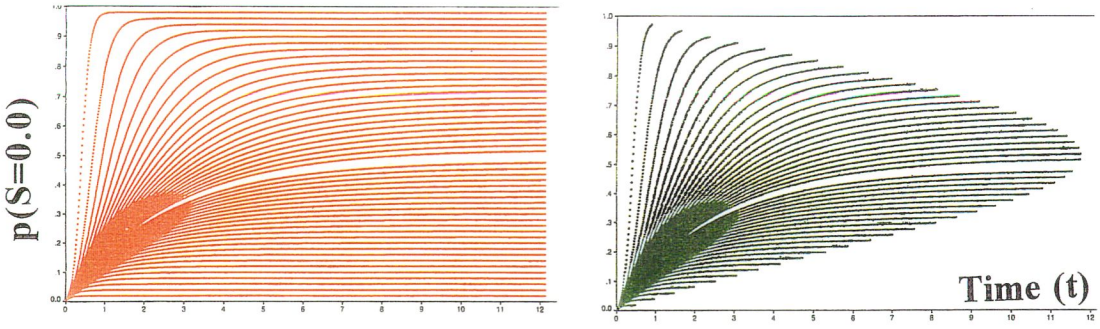


Fig.3 Results of simulation by the DDC model

(Left side) Relationship between the search time(t) and abnormal confidence level(p) curves simulated by the DDC model in the case of various p*; t $\rightarrow\infty$

(Right side) P-t curves of t up to p=0.99p*.

A position of preconception (S) is zero, which express that a subject have a preconceived idea prior to image readings.

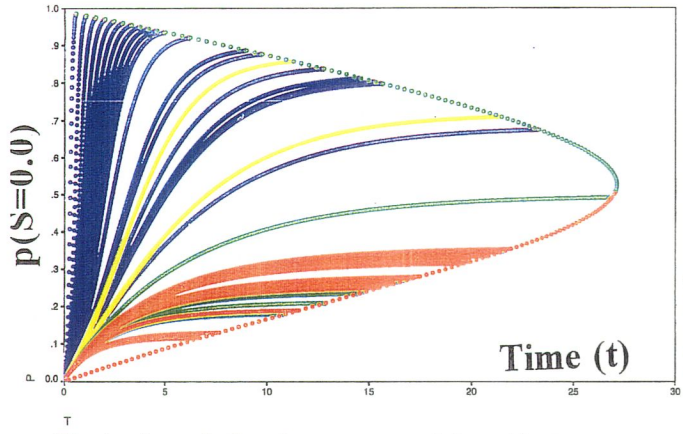


Fig.4 A result fitted experimental data (t) of detection of abnormal region on simulated p—t curves till p=0.99p* in the case of the performance study read each one slice from 100 patients.
(Blue curves is simulated for the ordinal score; 4 of equal interval by four steps and yellow curves score; 3, red curves score; 2, green curves; score 1, respectively.)

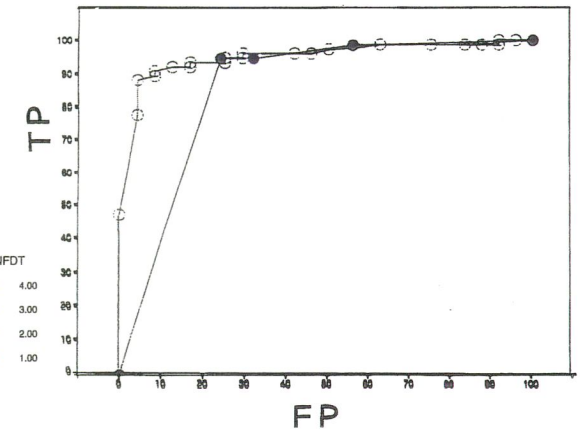


Fig.5 ROC curve made with continuously distributed probability (p) derived from the DDC model vs. conventional ROC curve (black circle) made with ordinal scores of equal interval four steps in the case of the detection of abnormal region.

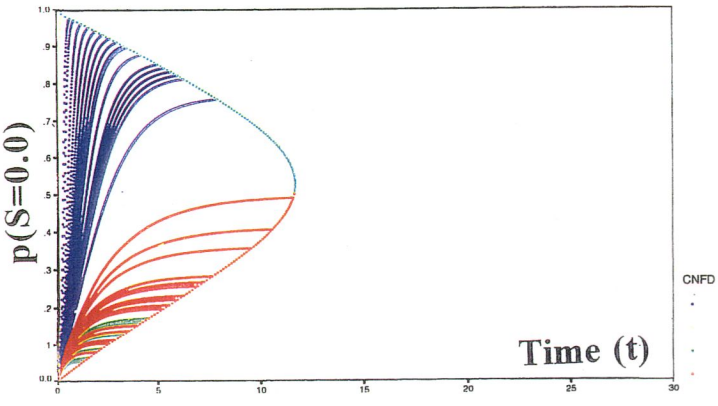


Fig.6 A result fitted experimental data (t) of differential diagnosis { non-cancer(normal or benign) vs. cancer}on simulated p—t curves till p=0.99p* in the case of the performance study read each one slice from 100 patients.
(Blue curves is simulated for the answer of "cancer and red curves "benign", green curves "normal", respectively.)

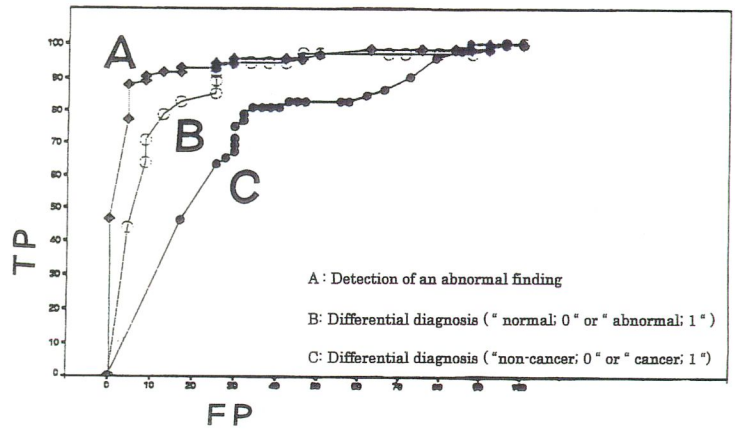


Fig.7 ROC curve made with continuously distributed probability (p) derived from the DDC model. Comparison of the performance of abnormal detection: A with the performance of differential diagnosis {B:normal vs. abnormal(benign or cancer) and C: non-cancer (normal or benign) vs. cancer}