

The Meta-Analysis of Fine-Needle Aspiration Biopsy in Breast Masses: Summary ROC Curve

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1. INTRODUCTION AND METHOD

Clinicians must decide whether to use a diagnostic test in a patient and determine how to interpret the result. Policy makers must assess the overall value of a test, compare it to alternatives, and decide whether the test should be made available. Some diagnostic tests have been evaluated dozens of times. Naturally, the various reports do not agree perfectly. Therefore, meta-analysis, the critical review and statistical combination of results of previous research, is potentially useful for assessing diagnostic accuracy. A meta-analytic method that uses linear regression to combine data from independent diagnostic test studies has been developed and applied in a number of areas. This method takes into account differences in test threshold and also provides a means of assessing the association between test accuracy and study characteristics. The standard errors of estimates from this model reflect between study variability. A summary ROC (SROC) curve can be estimated by regressing D on S where

$$D = \log\left[\frac{TPR}{1 - TPR}\right] - \log\left[\frac{1 - TNR}{TNR}\right] \quad (1)$$

$$S = \log\left[\frac{TPR}{1 - TPR}\right] + \log\left[\frac{1 - TNR}{TNR}\right] \quad (2)$$

The quantity D is the difference of the logits (log odds) of a positive test for individuals with and without disease and is equivalent to the log of the odds ratio between test results and true disease status. S, the sum of logits, gives the extent to which the log odds ratio is modified by changes in the test thresholds. If the odds ratio is constant across test thresholds (i.e., S=0), test accuracy can be conveniently summarized by the odds ratio alone. SROC analysis can examine whether test accuracy is associated with the test threshold. Next, we need to estimate the relationship between D and S. We fit a linear model (D=a+bS). Once we know the slope and intercept of the transformed line, we can use equation 3 to back transform it to the more familiar representation;

$$Q = \frac{1}{1 + \left\{ \frac{1}{e^{(a/(1-b))}} * (FPR/(1 - FPR))^{((1+b)/(1-b))} \right\}} \quad (3)$$

For practical purposes, if $-0.5 < b < +0.5$, the SROC curve looks reasonably like a typical ROC curve.

2. DATA ANALYSIS AND RESULTS

Fine Needle Aspiration (FNA) biopsy in breast masses, which is a cytologic diagnostic method, is fast, practical and cheap and does not necessitate anesthetics. However, there exists in literature an ambiguity to its diagnostic accuracy. In order to find the overall accuracy of the FNA biopsy, literature search was made, according to the inclusion criteria a total of 22 FNA studies have been included in the meta-analysis.

The results of the SROC curve that resulted from the true positive and false positive rates have shown an overall diagnostic accuracy (Q^*) of 0.95 (figure 1). The aspiration number,

inadequated material (%) and publication year assumed to be effective on the accuracy of FNA biopsy results and analyzed as subgroups.

While the overall diagnostic accuracy of studies published before 1990 was 0.94, that of the studies published after 1990 was found out to be 0.95. In this respect, it can be claimed that diagnostic accuracy of FNA biopsy does not portray a dramatic difference according to publication years. The cases with inadequate material below 10% have an overall diagnostic accuracy of 0.96, whereas those with that above 10% have 0.94 diagnostic accuracy. The number of aspirations applied to the case directly affects diagnostic accuracy. The overall diagnostic accuracy of cases with 2 to 6 aspirations have such a high level of 0.98 whereas cases with 1 aspiration are found out to have 0.93 (Table 1). The 5% difference between the two has been found as statistically significant ($p < 0.05$)

Table 1: The Results of SROC Curve

Parameters	All Studies	SUBGROUPS					
		Aspiration Number		Inadequate Material (%)		Publication Year	
		1	2-6	≤10%	>10%	≤1990	>1990
N#	22	14	8	11	11	12	10
A	6.012	5.333	6.998	6.313	5.599	5.87	6.067
B	- 0.122	- 0.45	- 0.353	- 0.027	- 0.309	- 0.058	- 0.324
Q*	0.95	0.93	0.98	0.96	0.94	0.94	0.95

The Number of Studies

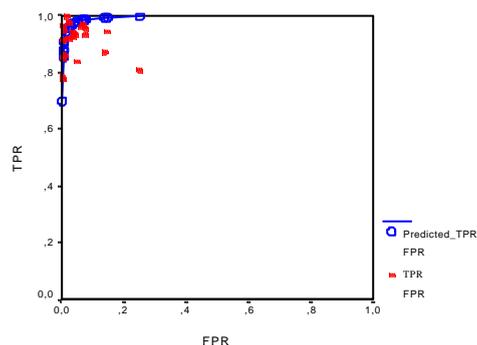


Figure 1: The SROC Curve for 22 FNA Studies

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RESUME

Pour justifier le diagnostic cumulatif dans une biopsie mammaire, une analyse META a été effectuée sur 22 travaux individuels. Le résultat justificatif du diagnostic cumulatif de la biopsie FNA par la méthode Summary ROC CURVE apparaît : 0,95.