Non-Echo Planar Diffusion-Weighted Imaging in the Preoperative Evaluation of Cholesteatoma: a Meta-analysis

Peter Li, M.D.¹, Eleni Linos, M.D., Dr.P.H.², Richard K. Gurgel, M.D.¹, Nancy J. Fischbein, M.D.¹,³, Nikolas H. Blevins, M.D.¹

¹Department of Otolaryngology – Head and Neck Surgery, Stanford University, Stanford, CA, U.S.A. ²Department of Dermatology, University of California San Francisco, San Francisco, CA, U.S.A. ³Department of Radiology, Stanford University, Stanford, CA, U.S.A.

INTRODUCTION

Although traditionally used for imaging cholesteatoma, a disadvantage of computer tomography (CT), is its low specificity in differentiating cholesteatoma from other soft tissue or fluid. This is particularly difficult in previously operated ears.

Magnetic resonance imaging (MRI) is becoming increasingly used as a tool for cholesteatoma diagnosis. In particular, non-echo-planar-based diffusion weighted imaging (DWI) techniques have been shown to have high reliability in detecting cholesteatoma with good interobserver agreement. These techniques have the advantage of being rapid, convenient and do not require the injection of contrast material. It has been suggested that the use of DWI MRI may reduce or even obviate the need for second-look surgery.

Our goal in this study was to quantify the summary sensitivity and specificity of DWI for preoperative detection of cholesteatoma.

METHODS AND MATERIALS

Two independent investigators performed a systematic review of the literature and relevant studies were selected. We included prospective studies of original data in which patients suspected of having cholesteatoma underwent both a preoperative, non-echo planar diffusion-weighted MRI scan and a subsequent otologic procedure for diagnosis and treatment.

For each study, the following variables were extracted: total number of patients, DWI MRI sequences and imaging parameters, the number of radiologists who reviewed the MR scans, the range of cholesteatoma size seen at surgery, the type of surgical procedure performed (primary or revision), the number of true positives (TP), false positives (FP), true negatives (TN), false negatives (FN), and sensitivity or specificity with confidence intervals.

We calculated the total true positives, false positives, true negatives and false negatives of all patients included in each study. Using the Metand command (STATA version 11, StataCorp LP, College Station, TX, USA), the summary sensitivity and specificity of the test, including 95% confidence intervals for each value were calculated. In addition, we calculated the 95% confidence regions and 95% prediction regions around the summary accuracy estimate.

RESULTS

The table describes the studies included in the final meta-analysis. The data items extracted include authors, publication year, country of origin, MRI sequence, number of radiologists reviewing images, patient population, type of procedure, sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV). The size limit represents the smallest size of cholesteatoma detectable by DWI MRI.

The overall pooled sensitivity was 0.94 (95% CI 0.80 to 0.98) and specificity 0.94 (95% CI 0.85 to 0.98). Figure 1 presents these measures of study accuracy in graphical form. This figure shows both the pooled summary sensitivity and specificity values or accuracy (red box) as well as the individual study values as circles with circle size proportional to study weight. The 95% confidence region, shown in yellow, is the two-dimensional analog of the 95% confidence interval for the pooled study accuracy based on the data included. The 95% prediction region, shown in gray, is a larger area because this reflects the area in which a future study could fall with 95% probability. The green curved line represents the receiver operator curve which reflects the curve on which different diagnostic thresholds would affect sensitivity and specificity, given a constant accuracy level (for example, if the radiologists’ threshold were to change based on cholesteatoma size).

CONCLUSIONS

Non-echo planar diffusion weighted MRI is highly sensitive and specific in identifying cholesteatoma. In selected cases, its use may obviate the need for second-look surgery.

REFERENCES