

Clinical evaluation of a fully automated Computer Aid Decision System (CADs) for brain tumour supported diagnosis. eTUMOUR project FP6-2002-LSH-503094

B. Celda^{1,2}, J. Gil Cano¹, M. Martinez-Bisbal², B. Martinez-Granados¹, and E. eTUMOUR-partners³

¹Physical Chemistry, University of Valencia, Burjassot, Valencia, Spain, ²Physical Chemistry, CIBER-BBN, Burjassot, Valencia, Spain, ³University of Valencia

Introduction

In vivo 1H MRS can provide significant metabolic information for supporting the diagnosis of different types of cancers, like brain, breast, prostate, colon and ovarian tumours among others. However, the added value of MRS strongly depends on a minimum expertise in processing and analyzing MRS spectra. Although this condition can be easily achieved in medical centres with multidisciplinary teams, it is not universally available for many radiological services. Therefore, a CADs system as automated as possible will be desirable for increasing the use of 1H MRS and for improving the diagnosis and prognosis of different types on cancers. In this communication, we will show the results of the clinical evaluation of the CADs developed in FP-VI eTUMOUR project used in a fully automated and objective manner for supporting brain tumour classification by exclusively using SV 1H MRS data.

Subjects and Methods

eTUMOUR CADs was installed in 7 different centres (Hospital La Ribera-Alzira, Hospital Clínico Universitario-Valencia, Hospital Quirón, Hospital Universitario Peset, Hospital Josep Trueta-Tarragona, IDI-Badalona, IRCCS - Fondazione Instituto Neurologico Mondino-Pavia). An on-line methodology was developed for CADs installation and training. CADs evaluation includes two different questionnaires and a minimum set of fully anonymized data for ten patients, enclosing: i) pathology results; ii) MRI diagnosis; iii) directly and automatic CADs classification and; iv) results of classification of brain tumours by using comparative analysis of average spectra and the spectrum under consideration. The CADs version 1.0.1 (Figure 1) used in this evaluation was designed for solving one of the significant questions, as proposed in the user's requirements: the differences in the aggressiveness in the most common brain tumours, glial, and the difference with meningiomas. SAS® Software was used for Statistical Analysis of CADs evaluation data. The percentage of positive results between CADs, average spectra, radiology and pathology results will be presented for the set of data used in the evaluation.

Results

An excellent result was obtained for CADs usefulness and applicability from the user's semiquantitative opinion, 86 and 71% respectively.

The overall capacity of predicting the true type of tumour (compared with histopathological data) has been calculated for HMRS-CADs and MRI. The percentage of true diagnosis has been calculated considering the true positive evaluations on all evaluations done (79 cases). The capacity of predicting the correct tumour type (compared with histopathological data) is 82.2% for CADs and 78.48% for MRI. The chi-square test comparing the two methods indicated non significant difference ($p = 0.548$). The overall prediction capacity has been finally computed also for the classification of tumours based on empirical evaluation of the average spectra, showing a percentage of 80.76.

Particularly significant are the results obtained for meningiomas, low grade and high grade glial tumours classification from CADs software in comparison to MRI results. For meningiomas the Sensitivity and Specificity were 0.70 and 0.91, respectively, for CADs classification and 0.75 and 0.99 for MRI diagnosis. However, for low grade glial tumours the Sensitivity and Specificity were 0.96 and 0.89 from CADs classification and 0.74 and 0.91 for MRI diagnosis. Finally, for high grade glial tumours the Sensitivity and Specificity were 0.77 and 0.91 from CADs classification and 0.83 and 0.84 for MRI diagnosis.

Discussion/Conclusion

After initial explanation of the characteristics of the MRS/CADs software, the impressions expressed by the investigators were of easy applicability of the system, user friendly interface, easy visualisation of MR spectra, and usefulness in the MR spectra processing. At the end of the study, such impressions were confirmed by most operators after having experienced the MRS/CADs system. The overall satisfaction was rated positively by five operators (71.4%), while two operators (28.6 %) were not satisfied (Figure 2). Secondary end-points, represented by the calculation of sensitivity / specificity of MRI and MRS/CADs to correctly diagnose brain tumors with reference to the final diagnosis based on all available diagnostic tools including biopsy, indicated slightly higher performance of HMRS-CADs, for low-grade and aggressive glial tumors whereas MRI showed an higher AUC in meningioma tumours..The overall percentage of prediction was higher (82.2%) for HMRS-CADs compared with MRI (78.5%). In addition, the empirical evaluation of the average spectra made by the expert radiologist showed a capacity of prediction of 80.76 with reference to the histopathological data.

Acknowledgments

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Figure 1.- Example of a final result of CADs automated classification for a GBM. Two TE spectra were used for automated classification of the brain lesion.

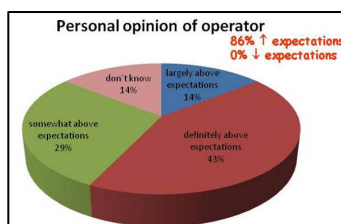


Figure 2.- Final result of personal opinion of users participating in CADs clinical evaluation.

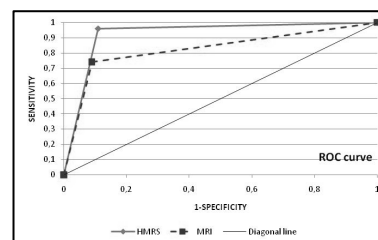


Figure 3.- ROC curve for low grade glial tumours classified by CADs and MRI. A better classification is obtained using MRS CADs result than MRI data.