MRI of the Lung to monitoring cystic fibrosis (CF) patients with pulmonary exacerbation

Giovanni Morana[1], Federica De Leo[1], Valentina Tavano[2], Andrea Mazzaro[2], Mirco Ros[3], Francesca Lucca[3], Pierluigi Ciet[4], and Silvia Bertolo[1]

[1]Radiology, Ca' Foncello Hospital, Treviso, Treviso, Italy, [2]Padova's Hospital, Padova, Padova, Italy, [3]Pediatrics, Ca' Foncello Hospital, Treviso, Treviso, Italy, [4]Radiology and Pediatrics Pulmonology, Erasmus MC, Rotterdam, Rotterdam, Netherlands

PURPOSE

CF is the most common lethal hereditary disease in the Caucasian. The cycle of obstruction, infection and inflammation is the main cause of lung damage, which leads to a poor prognosis in these patients[1]. Currently, no sensitive, radiation-free imaging methods are available to localize and quantify lung inflammation[2,3]. Recently PET-TC has been proposed in CF, but its use is limited by radiation exposure and high costs. Developments in MRI have made possible its larger use in thoracic imaging to obtain not only morphological, but also functional information[3]. Between functional methods, DWI has proven to be significantly useful in studying cellularity in thoracic neoplastic lesions and flogosis in bowel inflammatory disease[4,5].The aim is to assess the effectiveness of DWI in evaluation of flogosis in CF patients with pulmonary exacerbations and in therapy monitoring.

METHODS

In this study were enrolled 26 patients with pulmonary exacerbations and 24 patients in stable conditions. Morphologic MRI and functional DWI examinations were applied twice: pre and post (two weeks) antibiotic treatment for patients with exacerbations, after and before 2 weeks for patients in stable conditions. Images obtained with morphologic MR were valuated using modified Brody score[6], for DWI images was adopted a new score system designed by our team.
Moreover it was calculated the IVIM (Intravoxel Incoherent Motions) features with Matlab2010: D and D* (diffusion and pseudodiffusion coefficient), ADC (apparent diffusion coefficient) and f (perfusion fraction). The MR examinations were performed on a 1.5-T MRI (Siemens Avanto): Propeller BLADE PD (TR/TE/α: 1030/26 ms/150º) with navigator; "Steady State Free Procession" (SSFP, TrueFISP Siemens), in inspirium and expirium (TR/TE/α: 3/0.99 ms/66º); DWI EPI (TR/TE: 4100/52 ms) with eleven b-values (b = 0, 10, 20, 30, 50, 70, 100, 150, 200, 400, 800 sec/mm2). The statistical analysis and the validation of DWI score was performed by using SPSS 13.0 and winPEPI 11.15 softwares.

RESULTS

Both evaluation systems (Brody and DWI) found a statistically significant difference in the mean score at two population at first exhamination ($p < 0,001$ using T-Test for indipendent samples). At second exhamination a significant decrease in the mean score was noted in patients with exacerbation, in comparison to the first exhamination, using both score systems ($p < 0,001$ using T-Test for paired samples). After antibiotics therapy, DWI mean score in patients with exacerbations became very close to the mean score of patients in stable condition (p is not significant using T-Test for indipendent samples), while with Brody score the differences were maintained ($p < 0,001$). Between IVIM features, f parameter (perfusion fraction) had proven to has the most significant statistical effectiveness to differentiate patients with pulmonary exacerbations from patients in stable conditions at first examination (using R-square backward stepwise regression).

DISCUSSION

Both morphological and functional imaging techniques seems to be effective in differentiating patients with pulmonary exacerbations from patients in stable conditions and in therapy motitoring. Moreover, while morphological RM is more effective in describing irreversible structural alterations of lung parenchima, DWI seems to provide more informations than all other techniques in detecting reversible alterations, such as flogosis. This can lead to an important role in differentiating healthy tissue from inflammed tissue.

CONCLUSION

DWI seems to be a technique that could have an important role in clinical evaluation of patients with cystic fibrosis, for its effectiveness in assessing flogosis and in therapy monitoring. That can be part of clinical decision to start antibiotic therapy and to stop it once started.

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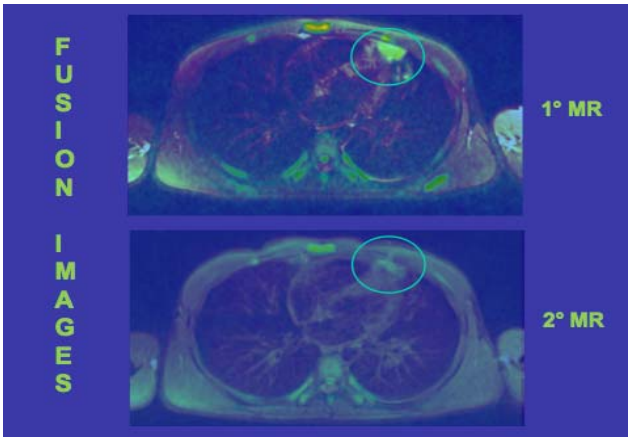
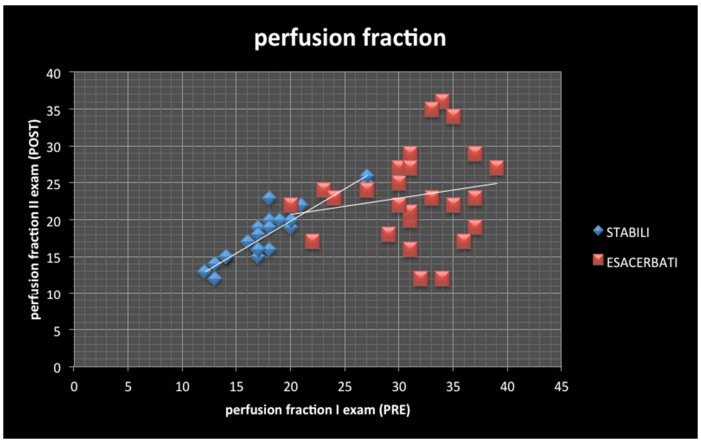


Examples of MR images of patient with exacerbation at the first and second examination



The graph shows f, the IVIM parameter, with the highest ability to discriminate between "exacerbated" and "stable" patients