Study on MRI Changes in Phenylketonuria in Patients Referred to Mofid Hospital/ Iran


Abstract

Objective
Phenylketonuria is one of the most common metabolic disorders and the first known cause of mental retardation in pediatrics. As screening for phenylketonuria (PKU) is not a routine neurometabolic screening test for neonates in Iran, many PKU cases may be diagnosed after developing the clinical symptoms. One of the findings of PKU is myelination disorders, which is seen as hypersignal regions in T2-weighted (T2W) and FLAIR sequences of brain MRI. The aim of our study was to assess MRI changes in PKU patients referred to Mofid Children’s Hospital, 2010-2011.

Materials & Methods
We studied all PKU cases referred to our clinic as a referral neurometabolic center in Iran for brain MRI and assessed the phenylalanine level at the time of Imaging. The mean phenylalanine level (in one year), clinical manifestations, and MRI pattern based on Thompson scoring, were evaluated.

Results
The mean age of our study group was 155±99 months and the mean diagnosis age was 37±27.85 months. There were 15 patients with positive and 15 with negative family history. The mean phenylalanine level at the time of imaging was 9.75±6.28 and the mean 1 year phenylalanine level was 10.28±4.82. Seventy percent of our patients had MRI involvement, in whom 20% showed atrophic changes, in addition to white matter involvement. Based on modified Thompson scoring, the score for our study group was 4.84.

The maximum involvement in MRI was in occipital region, followed by parietal, frontal, and temporal zones. There was not any correlation between MRI score and patients’ age. But we found significant relationship between MRI score and the age of regimen cessation. No correlation was seen between phenylalanine level (at the time of Imaging) and MRI score. But there was a relationship between mean 1 year phenylalanine level and MRI score.

Conclusion
According to the results of this study, brain MRI and white matter involvement can be used for evaluation of long-term control of phenylalanine level in PKU cases.

Keywords: Phenylketonuria; MRI; Thompson score

Introduction
Phenylketonuria (PKU) is the first known cause of mental retardation, the first
known metabolic disorder, and the first treatable inborn error of metabolism (1, 2).
Although, we have prenatal diagnosis of PKU and also diagnosis by screening methods in the first days of life, many of cases remains undiagnosed until they become symptomatic.
Because the screening methods for measurement of phenylalanine level were not routine in our country, many of cases are diagnosed after developing clinical symptoms.
PKU is characterized by mental retardation, microcephaly, blond hairs, and specific odor caused by the presence of keto acids in urine (3-6).
Severity of MRI findings (white matter involvement) correlates with mean phenylalanine level in the past years and point phenylalanine level at the time of imaging (7, 8).
Many studies showed correlation between phenylalanine level and MRI white matter involvement in conventional methods and with a higher sensitivity in DWI (9, 10).
In the present study, we aimed to evaluate the correlation between white matter involvement in T2-weighted (T2W) and FLAIR sequences of brain MRI in our patients and its relationship with clinical symptoms and demographic parameters.

Materials & Methods
In this cross-sectional study, all PKU cases referred to Neurology clinic of Mofid Children Hospital during the December 2010-September 2012 were enrolled. A questionnaire containing personal information of patients, time of diagnosis of disease, time of diet initiation, developmental status, mean phenylalanine level in the past year, the point phenylalanine level of patient at the time of imaging, and clinical manifestations of the disease was filled in. Phenylalanine level was measured by high-performance liquid chromatography (HPLC) method in a reliable laboratory center.
Brain MRI (T1W-T2W-FLAIR) was obtained for each patient. All of imagings were performed using a 1.5 Tesla scanner (Siemens) by conventional protocols in coronal, axial and sagittal view (9-11).
White matter involvement was scored based on modified Thompson scoring (Table1) by an expert neuroradiologist (12).
All collected data were analyzed by t-test and Spearman’s and Pearson’s Correlation coefficients using SPSS 18.

Table 1. Thompson scoring based on anatomic involvement

<table>
<thead>
<tr>
<th>Grade</th>
<th>Scan Appearance</th>
<th>Grade</th>
<th>Scan Appearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Normal</td>
<td>3</td>
<td>30-50% White matter involved</td>
</tr>
<tr>
<td>1</td>
<td>&lt;10% White matter involved</td>
<td>4</td>
<td>50-75% White matter involved</td>
</tr>
<tr>
<td>2</td>
<td>10-30% White matter involved</td>
<td>5</td>
<td>&gt;75% White matter involved</td>
</tr>
</tbody>
</table>

Six different part (frontal, parietal, temporal, occipital, brain stem, and other parts) of each hemisphere of brain were evaluated for white matter involvement and the involvement was graded 1.

Results
We studied 30 patients with PKU who were referred to neurology clinic of Mofid Children’s Hospital.
The mean age of our study group was 155±99 months, with minimum age of 10 and maximum age of 312 months.
Thirteen patients (43%) were female and 17 (57%) were male.
The mean age of diagnosis in our study was 37±27.85 months, with minimum age of 1 month and maximum age of 168 months.
The mean age of diet initiation was 44.61±33.95 months.
15 Patients (50%) had positive family history of PKU and the rest had negative.
Evaluation of motor and language development showed that all developmental milestones happened with delay in our study group. Speech delay was more severe. The mean phenylalanine level over the past year in our patients was lower than former studies (3-5). As this study was done in pediatric patients, most of our cases were under low phenylalanine diet and their phenylalanine level were lower than previous studies with wider age distribution (4-6).

White matter involvement was seen in 21 (70%) cases and this was less than other studies (4,7). This may be due to higher phenylalanine level in previous studies. On the other hand, some of prior studies had been designated based on DWI, which is more sensitive than conventional MRI imaging causing better detection of white matter involvement (5).

In our study, the maximum white matter involvement was in the occipital region and spreads to parietal and frontal areas in higher phenylalanine levels. This is compatible with previous studies (11,12).

MRI score (Thompson) had no correlation with patients’ age (p=0.176) similar to previous studies (4-6). MRI score had no significant relation with the age of diagnosis (p=0.369), which was consistent with other studies (7,8).

Our study shows more time from regimen cessation and more severe and extensive MRI involvement. Our study proved that there is a linear relationship between MRI score and age of regimen cessation (p=0.006).

We could not find any correlation between MRI score and present phenylalanine level (p=0.265). This is contrary to findings of previous studies, showed statistical correlation between MRI score and point phenylalanine level at the time of imaging (9-12).

This may be due to fluctuation in phenylalanine level in our studied group, which caused difference between point phenylalanine level at the time of imaging and mean 1 year phenylalanine level.

There is statistical correlation between MRI involvement and mean 1 years phenylalanine level of patients (p=0.017), which is compatible with previous studies.

In conclusion, considering cultural and economical limitation and trammels, assessment of mean 1 year phenylalanine level is the best indicator of white matter involvement.
involvement and has more relation with MRI score compared to point phenylalanine level at the time of imaging. Therefore, we can use brain MRI and white matter involvement for evaluation of long-term control of phenylalanine level in PKU cases.

Acknowledgement
Special Thanks to Dr Mohammad reza sharbatdar alayi for referring of phenylketonuria cases to child neurology clinic and Mrs gorji for statistical analysis of our data.

Author Contribution
Dr Karimzadeh:Chief Researcher
Dr Jafari: Corresponding Author
Dr Ahmadabadi:Science Author
Dr Hamid Nemati, Dr fakhtredin Shariatmadari:Case finding
Dr Ahadi, Dr Mirzarahimi, Dr Zare Nooghabi, Dr karimi Dardashti, Dr Dastborhan: corporate employee

References