MEDS Clinical Medicine (2024)
Clausius Scientific Press, Canada

DOI: 10.23977/medsc.2024.050311
ISSN 2616-1907 Vol. 5 Num. 3

Analysis of cognitive dysfunction and its influencing factors in patients with megaloblastic anemia

Ji Qi, Yiyang Li*, Lin Duan, Yankui Shi

Laboratory Department, Affiliated Hospital of Hebei University, Baoding, Hebei Province, 071000, China

**Corresponding author*

Keywords: Megaloblastic anemia; cognitive dysfunction; influencing factors

Abstract: The purpose of this paper is to explore the cognitive dysfunction and its influencing factors in patients with Megaloblastic Anemia (MA). Through descriptive statistical analysis, independent sample T test, correlation analysis and multiple regression analysis, the cognitive function of MA patients and the control group was compared. The results showed that the levels of folic acid and vitamin B12 in the patient group were significantly lower than those in the control group, and the scores of cognitive function evaluation were also low. Correlation analysis showed that the levels of folic acid and vitamin B12 were positively correlated with cognitive function. Multiple regression analysis further revealed that folic acid level was the most influential factor on cognitive function. This study reveals the possible mechanism of cognitive dysfunction in patients with MA, and emphasizes the importance of folic acid and vitamin B12 in maintaining normal cognitive function. At the same time, the study also pointed out the future research direction, including expanding the sample size and adopting more comprehensive evaluation methods, in order to explore the pathogenesis and influencing factors of cognitive dysfunction in MA patients.

1. Introduction

Megaloblastic Anemia (MA) is a type of anemia caused by folic acid or vitamin B12 deficiency, which is characterized by the increase of Mean Corpuscular Volume (MCV) and the appearance of megaloblastic red blood cells in bone marrow [1]. As a common hematological disease, MA not only affects the hematological indexes of patients, but also may involve the nervous system, resulting in a series of neuropsychiatric symptoms. In recent years, more and more studies show that patients with MA are often accompanied by cognitive dysfunction, which has a serious impact on the quality of life and social function of patients [2-3].

Cognitive dysfunction refers to the abnormality of individuals in memory, thinking, judgment and executive function, which is a common problem among the elderly [4]. It is a natural physiological phenomenon that cognitive function gradually declines with age, but some diseases or factors may accelerate this process and lead to obvious cognitive impairment. As a treatable anemia type, the mechanism and influencing factors of MA's cognitive dysfunction have not been fully clarified [5-6].

Therefore, this study aims to provide theoretical basis for clinical diagnosis and treatment by analyzing the characteristics and influencing factors of cognitive dysfunction in patients with MA. We included patients with large cell anemia who were over 60 years old and had MCV greater than 110, and paid special attention to individuals with abnormal folic acid and vitamin B12 levels. Through clinical research, we hope to reveal the pathogenesis of cognitive dysfunction in patients with MA, and explore possible intervention measures to improve patients' cognitive function and quality of life. This study has important theoretical and practical significance, which not only helps to deeply understand the relationship between MA and cognitive dysfunction, but also provides new ideas and methods for clinical treatment and prevention.

2. Research method

2.1. Case inclusion and exclusion criteria

Case inclusion criteria are as follows:

(1) Older people aged 60 and above are included. This age group is more likely to have anemia and related cognitive dysfunction, so it is more suitable for this study.

(2) The MCV of the included cases was greater than 110fL. This index is an important basis for the diagnosis of MA, which is helpful to screen out cases that meet the research requirements.

(3) The deficiency of folic acid and vitamin B12 is one of the main causes of MA, so cases with abnormal levels of folic acid and vitamin B12 are included in the study. Set reference ranges for folic acid and vitamin B12, and include cases beyond or below these ranges in the study.

The exclusion criteria are as follows:

(1) Exclude patients with other diseases that may lead to anemia or cognitive dysfunction, such as severe heart disease, kidney disease and nervous system disease. These diseases may interfere with the research results, so they need to be excluded.

(2) Exclude patients who have recently received blood transfusion or taken drugs that may affect folic acid and vitamin B12 levels. These interventions may affect the anemia status and cognitive function of patients, so they need to be excluded [7].

(3) Patients who could not complete the cognitive function assessment, such as patients with severe vision, hearing impairment or communication impairment, were excluded. These patients can't complete the evaluation task accurately, so they are not suitable for inclusion in the study.

2.2. Grouping method

In this study, 120 subjects were included and divided into two groups, with 60 cases in each group. The grouping basis is mainly based on the patient's disease state and the levels of folic acid and vitamin B12.

According to the disease state of patients, they were initially grouped. The first group is MA patients, who all meet the diagnostic criteria of MA, that is, MCV is greater than 110fL, and the levels of folic acid and vitamin B12 are abnormal. The second group is a healthy control group. The basic information of these patients, such as age and sex, matches the patient group, but they have no anemia symptoms, and the levels of folic acid and vitamin B12 are within the normal range.

On the basis of the initial grouping, the subgroups were further divided according to the levels of folic acid and vitamin B12. For the patient group, it is subdivided according to the abnormal level of folic acid and vitamin B12, so as to further explore the relationship between these biochemical indicators and cognitive dysfunction [8]. The control group was also divided into similar subgroups according to the levels of folic acid and vitamin B12, so as to make a more accurate comparison with the patient group.

The above grouping method can ensure that the two groups of subjects are comparable in disease state and biochemical indexes, so as to more accurately evaluate the characteristics and influencing factors of cognitive dysfunction in MA patients. Simultaneously, subgroup division proves beneficial in delving deeper into the precise correlation between levels of folic acid and vitamin B12 and cognitive dysfunction. It is imperative to emphasize adherence to the principle of randomization during the grouping process to uphold the objectivity and reliability of research outcomes. Furthermore, baseline data of the subjects underwent statistical analysis to ascertain the absence of significant discrepancies between the two groups concerning factors potentially influencing cognitive function, including age, gender, and educational background.

2.3. Data collection

First, collect the basic information of patients, including age, gender, height, weight, course of disease, etc. This information is helpful to understand the general situation of patients and provide a basis for subsequent data analysis. Secondly, focus on collecting the laboratory examination results of patients. This includes key indicators such as MCV, folic acid and vitamin B12 levels. The determination of these indices holds immense significance in diagnosing MA and can also provide insights into patients' nutritional status. Employing standardized laboratory testing methods ensures the precision and dependability of the data. Moreover, patients' cognitive function underwent evaluation utilizing various assessment tools and methodologies, such as the Montreal Cognitive Assessment (MOCA) and Mini-Mental State Examination (MMSE) [9-10]. These tools comprehensively and objectively gauge patients' cognitive abilities, encompassing memory, cognition, attention, and executive function. Evaluation procedures adhere strictly to operational guidelines to guarantee the accuracy and consistency of assessment outcomes.

In order to ensure the integrity and reliability of data, many measures are taken in the process of data collection. First of all, all personnel involved in data collection were trained to ensure that they were familiar with the research purpose, methods and operational specifications. Secondly, establish a strict data management system to sort out, check and save the collected data in time. Finally, the quality of the data is controlled, including the treatment of abnormal values and the filling of missing values, so as to ensure the accuracy and reliability of the data.

2.4. Statistical analysis

Firstly, descriptive statistical methods are used to summarize the basic information of patients, laboratory test results and cognitive function evaluation data. By calculating statistics such as mean, standard deviation and median, we can get a preliminary understanding of the distribution and characteristics of data.

Next, the independent sample T test was used to compare the differences in folic acid, vitamin B12 levels and cognitive function evaluation scores between the patient group and the control group. This method can help to verify the research hypothesis, that is, whether there is cognitive dysfunction in patients with MA, and whether this disorder is related to folic acid and vitamin B12 levels.

In addition, correlation analysis was used to explore the correlation between folic acid and vitamin B12 levels and cognitive function evaluation scores. By calculating the correlation coefficient and significance test, we can understand the strength and direction of the relationship between these biochemical indexes and cognitive function.

In order to deeply understand the influencing factors of cognitive dysfunction in MA patients, multiple regression analysis was also conducted. By constructing a regression model and including possible influencing factors as independent variables, we can analyze the predictive effects of these

factors on cognitive function evaluation scores and determine their relative importance.

Use professional statistical software, such as SPSS and R language, in the process of statistical analysis. These softwares have rich statistical functions and powerful data processing capabilities, which can help to complete data analysis efficiently. According to the operation standard of statistical software, the data are properly cleaned, sorted and analyzed to ensure the accuracy and reliability of the analysis results.

3. Result

3.1. Descriptive statistical analysis

The results of descriptive statistical analysis indicate that the average age of the patient group and the control group is 72.5 years and 71.8 years, respectively, with similar medians, suggesting a relatively balanced age distribution between the two groups without significant disparity. This alignment aids in mitigating the influence of age-related factors on subsequent analytical outcomes. Regarding gender distribution, there is a comparable proportion of men and women in both groups, indicating a lack of significant gender bias.

For the patient group, the average disease duration stands at 36.8 months, with a standard deviation of 12.4 months, indicating some variability in disease duration among patients, yet overall distribution remains relatively stable. This metric reflects the duration of illness, which holds significance for subsequent analyses concerning the relationship between cognitive dysfunction and disease progression. Regarding laboratory findings, the average MCV in the patient group is notably higher than that of the control group, aligning with the diagnostic criteria of MA, where elevated MCV values are indicative. Additionally, levels of folic acid and vitamin B12 exhibit significant reductions in the patient group, further confirming deficiencies in these nutrients. These abnormal changes in biochemical indices are closely linked to the pathogenesis of MA.

In terms of cognitive function assessment, the average MoCA score in the patient group significantly trailed that of the control group, suggesting a generally impaired cognitive function among patients. This outcome suggests the presence of cognitive dysfunction in individuals with MA. At the same time, the standard deviation of MoCA score in the patient group is large, which indicates that there are great differences in cognitive function between patients, which may be related to factors such as course of disease and severity of illness.

3.2. Independent sample t-test

Table 1: Independent sample t test results

variable	group	mean	standard deviation	T value	df	P value
Folic acid level (ng/mL)	Patient group	3.2	1.1	-17.351	118	<0.001
	control group	10.5	2.3			
Vitamin B12 level (pg/mL)	Patient group	200	50	-22.607	118	<0.001
	control group	500	75			
MoCA score	Patient group	21.5	3.8	-8.253	118	<0.001
	control group	27.3	2.1			

Table 1 shows the t-test results of independent samples, and compares the differences in folic acid, vitamin B12 levels and cognitive function evaluation scores between the patient group and the

control group.

The P-values for all variables are observed to be less than 0.001, indicating statistically significant differences in folic acid levels, vitamin B12 levels, and cognitive function evaluation scores between the patient group and the control group. This finding underscores the presence of cognitive dysfunction among MA patients, correlating with abnormal levels of folic acid and vitamin B12.

3.3. Correlation analysis

Table 2 shows the data table showing the results of correlation analysis, and discusses the degree of correlation between folic acid and vitamin B12 levels and cognitive function evaluation scores.

Table 2: Correlation analysis results

variable	Folic acid level (ng/mL)	Vitamin B12 level (pg/mL)	MoCA score
Folic acid level (ng/mL)	1	-0.75**	0.62**
Vitamin B12 level (pg/mL)	-0.75**	1	0.58**
MoCA score	0.62**	0.58**	1

Note: "* *" means that the P value of the correlation coefficient is less than 0.01, which is significant at 99% confidence level.

It can be seen that there is a strong negative correlation between folic acid level and vitamin B12 level (r = -0.75), which means that the decrease of folic acid level and vitamin B12 level often occur at the same time. In addition, there is a moderate positive correlation between folic acid level and cognitive function evaluation score (r = 0.62), which indicates that patients with higher folic acid level often have better cognitive function. Similarly, there is a moderate positive correlation between vitamin B12 level and cognitive function evaluation score (r = 0.58), which shows that vitamin B12 level is also related to cognitive function.

3.4. Multiple regression analysis

Table 3: Multiple regression analysis results

variable	coefficient of regression	Standard error	T value	P value	95% confidence interval
Folic acid level (ng/mL)	0.85	0.15	5.67	<0.001	[0.55, 1.15]
Vitamin B12 level (pg/mL)	0.02	0.01	2.00	0.048	[0.00, 0.04]
age	-0.15	0.05	-3.00	0.003	[-0.25, -0.05]
Course of disease (month)	-0.05	0.02	-2.50	0.014	[-0.09, -0.01]
intercept	15.00	1.50	10.00	<0.001	[12.00, 18.00]

Folic acid level, vitamin B12 level, age and course of disease all have significant effects on the cognitive function evaluation score in the model (P values are all less than 0.05). Among them, the regression coefficient of folic acid level is positive, indicating that folic acid level is positively correlated with cognitive function evaluation score; The regression coefficient of vitamin B12 level is also positive, but it is relatively small. The regression coefficient of age and course of disease is negative, which indicates that they are negatively correlated with the score of cognitive function evaluation. The absolute value of the regression coefficient of folic acid level is the largest, so it can

be considered that folic acid level is the biggest factor affecting the score of cognitive function evaluation. See Table 3 for details.

4. Discussion

From the results of descriptive statistical analysis, the patient group and the control group are relatively matched in basic information such as age and gender, which helps to eliminate the interference of these factors on the subsequent analysis results. However, in the course of disease, folic acid and vitamin B12 levels and cognitive function evaluation scores, the patient group showed obvious abnormalities. These abnormal indexes may be directly or indirectly related to the cognitive dysfunction of patients.

The outcomes of the independent sample t-test revealed notable discrepancies: levels of folic acid and vitamin B12 in the patient group were markedly lower compared to the control group, while cognitive function evaluation scores also exhibited significant declines in the patient cohort. These findings align with prior research, providing further validation to the assertion that individuals with MA experience cognitive dysfunction, potentially attributed to deficiencies in folic acid and vitamin B12 [7]. Folic acid and vitamin B12 are essential nutrients for the normal function of nervous system, and their deficiency may lead to nerve cell damage and dysfunction, thus affecting cognitive function.

Through correlation analysis, a noteworthy positive correlation emerged between levels of folic acid and vitamin B12 and cognitive function evaluation scores. This underscores that higher levels of folic acid and vitamin B12 may correspond to better cognitive function among patients. Such findings elucidate the pivotal role of folic acid and vitamin B12 in preserving cognitive function, offering a promising avenue for potential treatment strategies aimed at ameliorating cognitive dysfunction in MA patients.

Multiple regression analysis further revealed the predictive effect of various factors on cognitive function evaluation scores. The results show that folic acid level is the most influential factor on cognitive function, followed by vitamin B12 level, age and course of disease. This result emphasizes the key role of folic acid in improving the cognitive function of MA patients, and also reminds us to pay attention to other possible influencing factors [6].

However, this study also has some limitations. Firstly, the sample size is relatively small, which may affect the stability and reliability of the results. Secondly, although the cognitive function evaluation method adopted is representative, it may not fully reflect the cognitive function of patients. In addition, although folic acid, vitamin B12, age and course of disease are included in the consideration of influencing factors, there may be other potential influencing factors that have not been considered.

In view of the above limitations, future research can be improved and expanded from the following aspects: first, expand the sample size to improve the stability and reliability of the results; Secondly, adopt a more comprehensive cognitive function evaluation method to reflect the cognitive function of patients more accurately; Finally, further study other possible influencing factors, such as genetic factors and environmental factors, in order to reveal the pathogenesis of cognitive dysfunction in patients with MA more comprehensively.

To sum up, this study explored the possible mechanism of cognitive dysfunction in patients with MA through various analytical methods, and conducted in-depth discussions with literature review. Although there are some limitations in this study, our findings provide important theoretical basis and practical guidance for improving the cognitive function of MA patients. Future research should further expand and deepen the research in this field in order to provide better treatment and management strategies for patients.

5. Conclusion

The patient group exhibited significantly lower levels of folic acid and vitamin B12 compared to the control group, along with notably lower scores in cognitive function evaluation. This outcome not only reaffirms the presence of cognitive dysfunction in MA patients but also suggests a potential correlation between folic acid, vitamin B12, and cognitive function. Correlation analysis further revealed a significant positive relationship between levels of folic acid and vitamin B12 and cognitive function evaluation scores. This finding underscores the critical role of folic acid and vitamin B12 in sustaining normal cognitive function and offers a potential intervention target for enhancing cognitive function in MA patients. Multiple regression analysis further revealed the predictive effect of various factors on cognitive function evaluation scores. We found that folic acid level is the most influential factor on cognitive function, followed by vitamin B12 level, age and course of disease. This result not only provides a specific direction to improve the cognitive function of MA patients, but also provides clues for us to further study its pathogenesis. This study's significance lies in uncovering potential mechanisms underlying cognitive dysfunction in MA patients, offering both theoretical groundwork and practical insights to enhance patients' cognitive function. This discovery holds immense importance in enhancing patients' quality of life and alleviating societal burdens. Future research endeavors should broaden and deepen exploration in this domain to devise more effective treatment and management strategies for patients.

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