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Research Article

Diffusion MRI Evaluation of Vitreous Humor Changes in Diabetic Retinopathy Patients

Diyabetik Retinopatili Hastalarda Humor Mizah Değişikliklerinin Difüzyon MRG ile Değerlendirilmesi

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Abstract

Aim: The objective of this study was to use diffusion-weighted imaging (DWI) to determine changes in the vitreous humor in diabetic retinopathy patients.

Materials and Methods: All diabetic retinopathy patients over the age of 18 who had brain diffusion magnetic resonance imaging between May 1, 2019, and May 1, 2021, and whose images were available in the radiological information system were retrospectively scanned on our database. The study included 51 diabetic retinopathy patients and 51 non-diabetic control group patients. The t-test was used to compare the values of the vitreous humor apparent diffusion coefficient (ADC) in diabetic retinopathy patients with control group patients.

Results: Patients with diabetic retinopathy had significantly higher minimum, median, and maximum ADC mean values in the right eye than the control group (p=0.011, p=0.007, p=0.026). Patients with diabetic retinopathy had significantly higher median and maximum ADC averages in the left eye than those in the control group (p=0.020, p=0.012). Although the mean minimum ADC of the left eye was higher in diabetic retinopathy patients than in the control group, the difference was not statistically significant (p=0.387).

Conclusion: Because of the rise in ADC values in diabetic retinopathy patients compared to the normal control group, we detected that DWI could be used to assess if the vitreous humor is affected in this disease.

Keywords: Diabetic Retinopathy, diffusion MRI, vitreous humor, eye

Öz

Amaç: Bu çalışmada, diyabetik retinopatili hastalarda vitreus humor 'de oluşan değişiklikleri difüzyon ağırlıklı görüntüleme (DAG) ile belirlemeyi amaçladık.

Materyal ve Metot: 01 Mayıs 2019 ile 01 Mayıs 2021 tarihleri arasında beyin difüzyon manyetik rezonans görüntüleme yapılmış ve görüntüleri radyoloji bilgi sisteminde bulunan, 18 yaşından büyük olan tüm diyabetik retinopati hastaları veri tabanımızda retrospektif olarak tarandı. Görüntüsü artefaktlı olanlar, vitreus kanaması, glokom, kontrolsüz hipertansiyon olan hastalar çalışma dışında bırakıldı. Sonuçta, 51 diyabetik retinopati hastası ve diyabet hastası olmayan 51 kontrol grubu hastası çalışmaya dahil edildi. Diyabetik retinopatili hastalar ile kontrol grubu hastalarının vitreus humor görünür difüzyon katsayısı (ADC) değerleri t testi ile karşılaştırıldı.

Bulgular: Diyabetik retinopatili hastaların sağ gözde minimum, ortanca ve maksimum ADC ortalamaları kontrol grubu hastalarına göre anlamlı yüksekti (p=0,011, p=0,007, p=0,026). Diabetik retinopatili hastaların sol gözde ortanca ve maksimum ADC ortalamaları kontrol grubu hastalarına göre anlamlı yüksekti (p=0,020, p=0,012). Sol göz minimum ADC ortalaması diyabetik hastalarda kontrol grubuna göre yüksek olmakla birlikte istatistiksel olarak anlamlı değildi (p=0,387).

Sonuç: DAG ile diyabetik retinopatili hastalarda ADC değerlerinde normal kontrol gurubuna göre artış olması nedeniyle vitreus humor 'un bu hastalıkta etkilenip etkilenmediğinin değerlendirilmesinde kullanılabileceğini saptadık.

Anahtar Kelimeler: Diyabetik Retinopati, difüzyon MRG, vitreus humor, göz

INTRODUCTION

The vitreous makes up about 80% of the volume of the eye and is the transparent part between the lens and the retina. Its structure includes hyaluronic acid, type 2 collagen, and water molecules (1).

Diabetes results in capillary basement membrane thickening, loss of intramural pericytes, and endothelial cell damage. The increase in erythrocyte and thrombocyte aggregation and high fibrinogen levels also contribute to vascular occlusion. Thus, developing capillary and

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arteriolar occlusion creates retinal hypoxia, which drives the retina to release angiogenic factors, which cause the formation of new vessels in various areas of the eye (retina, optic disk, iris, anterior chamber angle). These veins are abnormal veins that bleed easily. Moreover, microaneurysms and increased permeability result from cell loss in the retinal vessel wall, and retinal macular edema develops due to microaneurysms and deterioration of the internal blood-retinal barrier (2).

Diffusion-weighted imaging (DWI) is a method of magnetic resonance imaging (MRI) based on the random motion of water molecules. The amount of diffusion is influenced by the adjacent environment and the anatomical and physiological structures. Furthermore, the amount of diffusion and the tissue's cellular density have an inverse relationship. When cell density rises, diffusion is limited, and a low signal is acquired in DWI, whereas when cell density lowers, diffusion increases and a high signal is obtained in DWI. The apparent diffusion coefficient (ADC) values and region of interest (ROI) from ADC maps in diffusion MRI are used to obtain quantitative values (3,4). Tight junctions connect the endothelium on the inner surface of retinal vessels to each other. Large and non-carrier molecules are prevented from leaking into the retina and vitreous by these tight junctions, which operate as barriers. In diabetic retinopathy, this barrier, known as the blood-retina barrier, is disrupted, resulting in leakage into the retina and vitreous (5).

The structural content of the vitreous humor changes in patients with diabetic retinopathy (DR); these changes can be assessed with DWI. This study aimed to determine the changes in ADC values due to retinopathy in the vitreous humor.

MATERIAL AND METHOD

51 (29 female, 22 male) patients diagnosed with diabetic retinopathy who underwent diffusion MRI for any reason between May 01, 2019, and May 01, 2021, at Malatya Training and Research Hospital were included in the study. Moreover, 51 (29 female, 22 male) patients from the control group were included in the study, randomly selected at the same dates and matched for age and gender and underwent diffusion MRI for any reason. All patients were evaluated with a standard head-neck coil with a 1.5 T MRI unit. The system generated ADC maps automatically from images with b values of 50 and 1,000. Two radiologists were blinded to the patients' clinical information when evaluating MR images. The minimum, median, and maximum ADC values were measured by placing ROI on the vitreous humor (average 20 mm^2 in all patients) in the right and left orbit (Figure 1).

Statistical analysis

For statistical analysis, the SPSS version 22.0 program was used. For comparisons, the t-test was used. Statistical significance value was accepted as $p<0.05$.

Ethical approval, This retrospective study received ethical approval from the Malatya Turgut Özal University Clinical Research Ethics Committee. Decision no: 2021/90.

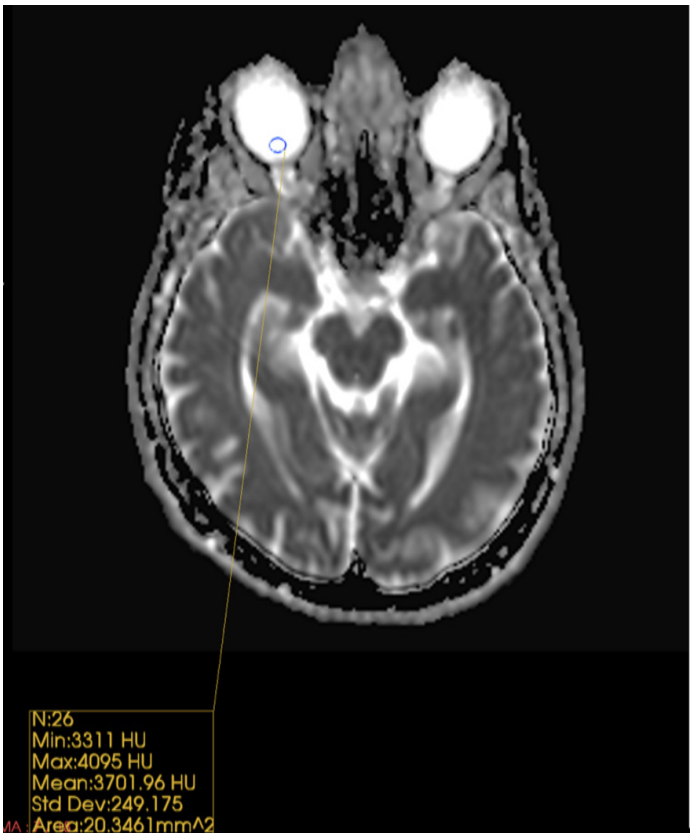

Figure 1. The minimum, median, and maximum ADC values were measured by placing the ROI on the vitreous humor in orbit

RESULTS

58 (56.9%) of the patients were women. The patients' ages ranged from 41 to 88 years old, with a mean of 63.06±9.90. Patients with diabetic retinopathy had significantly higher minimum, median, and maximum ADC mean values in the right eye than the control group ($p=0.011$, $p=0.007$, $p=0.026$).

Table 1. Average ADC values of patients with Diabetic Retinopathy and the control group

VITREOUS HUMOR (VH) ADC	Patients with retinopathy (n=51) Average ADC±SD	Control group (n=51) Average ADC±SD	p
Right VH Min. ADC	2957.6±268.1	2813.9±180.6	0.011
Right VH Avg. ADC	3229.3±281.7	3013.0±193.8	0.007
Right VH Max. ADC	3550.3±319.7	3219.4±234.1	0.026
Left VH Min. ADC	2875.6±214.6	2810.3±189.0	0.387
Left VH Avg. ADC	3167.0±245.5	3006.6±181.9	0.020
Left VH Max. ADC	3477.0±310.4	3199.9±224.5	0.012

SD: Standard deviation; p values were calculated by t-test.
Max.: Maximum, Min.: minimum, Avg.: average

Patients with diabetic retinopathy had significantly higher median and maximum ADC averages in the left eye than those in the control group (p=0.020, p =0.012). Although people with diabetes had a higher mean minimum ADC of the left eye than the control group, this was not statistically significant (p=0.387). Table 1 shows the ADC averages and p-values.

DISCUSSION

Diabetic retinopathy is the leading preventable and/or treatable cause of blindness worldwide in the 20-65 age group. It is one of the most severe complications of diabetes mellitus. The risk of blindness is increased 25 times more compared with the general population (6). Blindness in DR patients is frequently caused by vitreous hemorrhage, tractional retinal detachment, or diabetic macular edema (7).

At DR, pathological changes are observed with increased leukocyte adhesion to vessel walls, death of pericytes, and thickening of the vascular basement membrane. The weakening of endothelial cell connections causes increased vascular permeability. If the fluid leakage is large enough, lipid accumulation in the retina may occur (8). DWI can be used to assess changes in the permeability of cell membranes, changes in water content, such as cell lysis, and morphological and physiological changes in tissues (9). DWI can also be used to assess the microstructural structure of tissues (10). In our study, we assume that DR -related changes in vitreous humor can be detected by DWI.

Our research discovered that patients with DR have high ADC values in vitreous humor in all measurements in the right eye and high maximum and median values in the left eye. Although the minimum ADC value was higher in the left eye than in the normal group, it was not statistically significant. This, we think, is due to the limited number of patients that we have. We think that the increased vascular permeability at DR causes more fluid to enter the vitreous and, accordingly, ADC levels increase.

A low ADC value indicates limited or restricted diffusion and is observed in highly cellular tissues. On the other hand, a high ADC value is observed in structures with relatively free diffusion of tissue fluid, with low cellularity, or in cystic structures (11).

Aldose reductase converts glucose to sorbitol in hyperglycemia. Therefore, sorbitol concentration in the cell may increase to a high level. Sorbitol can lead to an increase in osmolarity (12). We believe that the high ADC values we measured in our study are due to impaired vascular permeability, as more fluid leaks into the extracellular space in DR patients.

DWI is known to be used to diagnose endophthalmitis, optic nerve infarction, orbital cellulitis, pseudotumor, differentiation of lymphoid lesions, diagnosis of orbital abscesses, and characterization of retinoblastoma in pediatric patients, and differentiation of benign and malignant ocular tumors (13). DWI can also be used to assess the microstructural structure of the tissue, so changes due to DR can be detected with DWI. Our research discovered that DWI could be used to evaluate changes in the vitreous humor caused by an increase in ADC values in patients with DR compared to the control group.

Our study's main limitations are the insufficient number of patients and the retrospective character of the study.

CONCLUSION

Using the values from ADC may be essential to understand the structural changes in the vitreous humor due to DR, provide better treatment, and follow up on treatment. More comprehensive studies are still needed on this topic.

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Conflict of Interest: *The authors declare that they have no competing interest.*

Ethical approval: *This retrospective study received ethical approval from the Malatya Turgut Ozal University Clinical Research Ethics Committee. Decision no: 2021/90.*

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