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Research Article

Evaluation of clinical and radiological findings in children with juvenile idiopathic arthritis

Çocuklarda Juvenil İdiyopatik Artritte Klinik ve Radyolojik Özelliklerin Değerlendirilmesi

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Abstract

Aim: Juvenile idiopathic arthritis (JIA) is the most prevalent chronic rheumatologic condition in children. Determining radiological progression in relation to clinical and laboratory parameters is crucial for initiating early intervention. This study aimed to investigate the association between diagnostic delay, human leukocyte antigen B27 (HLA-B27) positivity, and the development of late radiological changes in children with JIA.

Material and Methods: This retrospective single-center study included 96 patients diagnosed with JIA between January 2006 and April 2015. Demographic, clinical, laboratory, and radiological data were reviewed. Radiological changes emerging after one year of disease onset were defined as late radiological findings. Clinical features, laboratory markers, and treatment modalities were compared between patients with early and late radiological changes.

Results: The mean age at diagnosis was 8.8 ± 4.0 years; 67.7% were female. Oligoarticular JIA was the most common subtype, occurring in 67 patients (69.8%), followed by systemic JIA in 20 patients (20.8%) and polyarticular JIA in 9 patients (9.4%). Late radiological changes were observed in 35 patients (36.5%). HLA-B27 positivity (20.0% vs. 6.6%, p=0.049), longer diagnostic delay (3.3 ± 2.0 vs 2.0 ± 1.8 years, p=0.002), higher joint involvement (5.6 ± 3.6 vs. 4.2 ± 2.7, p=0.033), and extra-articular findings (68.6% vs. 27.9%, p=0.001) were associated with late radiological changes. Antinuclear antibody (ANA) test positivity was inversely associated (40.0% vs. 62.3%, p=0.034).

Conclusions: HLA-B27 positivity and diagnostic delay were associated with late radiological changes in children with JIA. Early diagnosis and close radiological monitoring may help prevent long-term joint damage.

Keywords: Juvenile idiopathic arthritis, HLA-B27 antigen, diagnostic delay, radiological progression, pediatric rheumatology.

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Öz

Amaç: Juvenil idiyopatik artrit (JİA), çocuklarda en sık görülen kronik romatolojik hastalıktır. Klinik ve laboratuvar parametreleri ile ilişkili radyolojik ilerlemenin belirlenmesi, erken müdahalenin başlatılması için çok önemlidir. Bu çalışmanın amacı, JİA'lı çocuklarda tanı gecikmesi, insan lökosit antijeni B27 (HLA-B27) pozitifliği ile geç dönem radyolojik değişikliklerin gelişimi arasındaki ilişkinin araştırılmasıdır.

Gereç ve Yöntemler: Bu retrospektif tek merkezli çalışma, Ocak 2006 ile Nisan 2015 tarihleri arasında JIA tanısı konulan 96 hasta dahil edildi. Demografik, klinik, laboratuvar ve radyolojik veriler incelenmiştir. Hastalığın başlangıcından bir yıl sonra ortaya çıkan radyografik değişiklikler "geç dönem radyolojik bulgular" olarak tanımlanmıştır. Erken ve geç radyolojik değişiklikleri olan hastalar klinik özellikler, laboratuvar belirteçleri ve tedavi yöntemleri açısından karşılaştırılmıştır.

Bulgular: Tanı anındaki ortalama yaş 8,8 ± 4,0 yıl olup, hastaların %67,7'si kızdı. En yaygın alt tip oligoartiküler JIA olup 67 hastada (%69,8) görülmüştür, bunu 20 hastada (%20,8) sistemik JIA ve 9 hastada (%9,4) poliartiküler JIA izlemiştir. Geç radyolojik değişiklikler 35 hastada (%36,5) saptandı. HLA-B27 pozitifliği (%20'e karşı %6,6; p=0,048), daha uzun tanı gecikmesi (3.3 ± 2.0 karşı 2.0 ± 1.8 yıl; p=0,002), daha yüksek eklem tutulumu (5,6 ± 3,6'ya karşı 4,2 ± 2,7; p=0,032) ve ekstraartiküler bulguların varlığı (%68,6'ya karşı %27,9; p=0,001) geç radyolojik değişiklikler ile ilişkiliydi. Antinuclear antibody (ANA) test pozitifliği ise ters yönde ilişkili bulundu (%40'a karşı %62.3; p=0,034).

Sonuç: HLA-B27 pozitifliği ve tanı gecikmesi, JİA'lı çocuklarda geç dönem radyolojik değişikliklerle ile ilişkilidir. Erken tanı ve düzenli radyolojik izlem, uzun dönem eklem hasarının önlenmesine katkı sağlayabilir.

Anahtar Kelimeler: Juvenil idiyopatik artrit, HLA-B27 antijeni, Tanı gecikmesi, Radyolojik progresyon, Pediatrik romatoloji.

Introduction

Juvenile idiopathic arthritis (JIA) is the most common chronic rheumatic condition of childhood, representing a heterogeneous collection of disorders defined by chronic synovial inflammation [1]. A number of subtypes are included in the classification, one of which is enthesitis-related arthritis (ERA), which is of particular interest due to axial involvement and unfavourable outcomes [2]. Despite advances in diagnosis and treatment, delays in the diagnosis of JIA remain common, particularly in subtypes that lack obvious systemic manifestations [3-5].

Delayed JIA diagnosis has been associated with poorer clinical outcomes such as joint damage, ongoing disease activity, and reduced functional capacity [6]. Delays in diagnosis of more than six months have been associated with an increased risk of joint erosions and osteopenia. Nevertheless, the specific variables associated with late radiological changes differ between populations, such as demographic, socioeconomic, and clinical presentation factors [7-11].

Human leukocyte antigen B27 (HLA-B27) is closely linked with ERA and sacroiliitis in JIA [12]. It is also recognized to convey greater risk for axial involvement, greater radiological damage, and a resistant disease course. Nevertheless, the presence of HLA-B27 alone could potentially not completely explain structural joint change progression, and it is necessary to study its interaction with other clinical factors, including diagnostic delay [13-15].

Although diagnostic delay and HLA-B27 positivity have each been linked to less favorable outcomes in JIA, their relationship with late radiological changes in a clinically characterized pediatric cohort, together with accompanying laboratory and extra-articular features, remains insufficiently defined. Therefore, this study aimed to investigate the association of clinical and laboratory factors with late radiological changes in children with JIA.

Material And Methods

This retrospective study was conducted at the Pediatric Rheumatology Outpatient Clinic of Istanbul Medeniyet University Goztepe Training and Research Hospital between January 2006 and April 2015. Ethical approval was obtained from the İstanbul Medeniyet University Goztepe Training and Research Hospital Ethics Committee (Approval No: 2015/0028; Date: April 21, 2015) in accordance with the principles of the Declaration of Helsinki and local ethical regulations.

Study population

During the study period, the medical records of 124 patients diagnosed with juvenile idiopathic arthritis according to the International League of Associations for Rheumatology (ILAR) criteria were retrospectively reviewed [16]. Patients under 16 years of age who had regular follow-up for at least one year, had undergone joint imaging (ultrasound and/or magnetic resonance

imaging), had no additional chronic illnesses, and presented for regular clinical evaluations were considered eligible. Consequently, 96 patients were included in the final analysis.

Data collection

The investigation was conducted in three phases in sequence. During phase one, demographic information (age, sex, age at onset of disease, age at diagnosis, body mass index), clinical features (number and types of joints involved and extra-articular manifestations, including uveitis and other documented systemic or periarticular clinical findings), and laboratory findings [antinuclear antibody (ANA), rheumatoid factor (RF) and HLA-B27 status] were documented. In cases of ERA, due to overlapping oligoarticular involvement, patients were categorized under the oligoarticular subtype in accordance with prior classification approaches [16].

In the second phase, all available imaging records, including ultrasonography and/or magnetic resonance imaging findings, were reviewed retrospectively, and the detected radiological findings were categorized as early or late radiological changes. Radiological findings early on were soft tissue swelling, periarticular osteopenia, new bone formation, and joint space widening as a result of synovial hypertrophy. Late findings were categorized as subchondral erosion, loss of cartilage, ankylosis, subluxation, narrowing of joint space, and fusion of bones [17].

During the third stage, the correlation of radiological classification (early vs. late changes) with clinical variables like diagnostic delay, JIA subtype, HLA-B27 status, ANA and RF positivity, joint count, and extra-articular manifestations was subjected to statistical analysis.

Data were gathered with a standardized data form created for the purpose of this study. The form contained demographic data, disease characteristics, and radiological/laboratory results. Diagnostic delay was calculated as the number of months from disease onset to established diagnosis.

Statistical analysis

Statistical analysis was performed using the NCSS 2007 (Number Cruncher Statistical System, Utah, USA). The normality of distribution for continuous variables was assessed using the Kolmogorov–Smirnov test. Numerical variables were presented as mean ± standard deviation (SD). Comparisons between two independent groups were performed using the Student's t-test for normally distributed variables, and the Mann–Whitney U test for non-normally distributed variables. For comparisons involving more than two groups, one-way analysis of variance (ANOVA; post-hoc test: Tukey HSD) or the Kruskal–Wallis test (post-hoc test: Dunn's test) was used, depending on the distribution. Categorical variables were expressed as counts and percentages, and compared using the Chi-square or Fisher's exact test, as appropriate. A p-value < 0.05 was considered statistically significant.

Results

Ninety-six pediatric patients with JIA were enrolled in the study. There were 65 females (67.7%) and 31 males (32.3%). The age at the time of the study was 12.2 ± 5.3 years. The mean age at diagnosis was 8.8 ± 4.0 years, while the mean age at onset of the disease was 6.1 ± 3.2 years, representing about a 2.7-year diagnostic delay. The mean follow-up period was 4.3 ± 2.8 years. Oligoarticular JIA was the most common subtype, occurring in 67 patients (69.8%), followed by systemic JIA in 20 patients (20.8%) and polyarticular JIA in 9 patients (9.4%) (Table 1). NSAIDs were administered to all 96 patients. Methotrexate (MTX) was used in 79 patients (82.3%), systemic corticosteroids in 22 patients (22.9%), biological agents in 24 patients (25.0%), and intra-articular steroid injections in 38 patients (39.6%)

Radiological assessments showed a wide spectrum of joint involvement in the patient cohort. Joint effusion was the most common imaging finding and was observed in 67 of 96 patients (69.8%). Synovial hypertrophy was observed in 63 patients (65.6%). Soft tissue edema was noted in 42 patients (43.8%). Bone marrow edema was found in 15 patients (15.6%). Bone erosions were identified in 11 patients (11.5%), while subchondral cyst formation was detected in 6 patients (6.3%). A swan-neck deformity was observed in 1 patient (1.0%). Normal imaging findings were present in 6 patients (6.3%) (Table 2).

Clinical and laboratory features were also compared among JIA subtypes. Mean age was similar in the subtypes: 12.4 ± 5.3 years in oligoarticular, 13.8 ± 7.5 years in polyarticular, and 10.9 ± 4.3 years in systemic subgroups ($p = 0.325$). Likewise, no distinction was observed in age at diagnosis ($p = 0.920$) or disease onset age ($p = 0.574$). ANA positivity was most frequent in the oligoarticular subset (62.7%) and less frequent in polyarticular (44.4%) and systemic (30%) types, although the difference did not reach statistical significance ($p = 0.301$). RF positivity, reflecting seropositive polyarthritis, was higher in the polyarticular subset (22.2%) compared to oligoarticular (3.0%) and systemic (5.0%) types, however, this difference was not statistically significant ($p = 0.115$). HLA-B27 positivity was observed in 13.4% of oligoarticular patients and 5.0% of systemic patients, whereas no polyarticular patient was

HLA-B27 positive; however, the difference between subtypes was not statistically significant (p = 0.665). The number of joints affected varied significantly among subtypes (p < 0.001), with the polyarticular patients having the greatest mean joint involvement (9.1 ± 4.3), followed by systemic (5.5 ± 3.7) and oligoarticular (3.2 ± 1.5) groups (Table 3).

Clinical and laboratory characteristics were compared between patients with early (n = 61) and late (n = 35) radiological findings. Although mean age (11.8 ± 5.3 vs. 12.7 ± 5.4 years, p = 0.445), age at diagnosis (8.3 ± 3.8 vs. 9.2 ± 4.0 years, p = 0.276), and age at disease onset (6.3 ± 3.3 vs. 5.8 ± 3.0 years, p = 0.462) were similar, ANA positivity was significantly higher in the early group (62.3%) compared to the late group (40.0%) (p = 0.034). Conversely, HLA-B27 positivity was more frequent among those with late findings (20.0% vs. 6.6%, p = 0.048). The late radiological group also showed a higher rate of extra-articular manifestations (68.6% vs. 27.9%, p = 0.001), a greater mean number of affected joints (5.6 ± 3.6 vs. 4.2 ± 2.7, p = 0.033), and a significantly longer diagnostic delay (3.3 ± 2.0 vs. 2.0 ± 1.8 years, p = 0.002). RF positivity showed no significant difference between the groups (p = 0.856) (Table 4).

Table 1. Demographic and clinical characteristics of the study cohort.

Variables	All patients n = 96
Total number of patients, n	96
Sex, female/male, n (%)	65 (67.7%) / 31 (32.3%)
Age (mean ± SD), years	12.2 ± 5.3
Age at diagnosis (mean ± SD), years	8.8 ± 4.0
Age at disease onset (mean ± SD), years	6.1 ± 3.2
Follow-up duration (mean ± SD), years	4.3 ± 2.8
JIA subtypes, n (%)	
Oligoarticular	67 (69.8%)
Polyarticular	9 (9.4%)
Systemic	20 (20.8%)

Categorical variables were shown as number percentages. Numerical variables are mean (SD). Abbreviations: JIA, juvenile idiopathic arthritis; SD, standard deviation.

Table 2. Distribution of radiological findings in the study cohort.

Variables	All patients n = 96
Joint effusion	67 (69.8%)
Synovial hypertrophy	63 (65.6%)
Soft tissue edema	42 (43.8%)
Bone marrow edema	15 (15.6%)
Erosion	11 (11.5%)
Subchondral cyst	6 (6.3%)
Swan-neck deformity	1 (1.0%)
Normal radiological finding	6 (6.3%)

Categorical variables were shown as number percentages.

Table 3. Comparison of clinical and laboratory findings according to JIA subtypes.

Variables	Oligoarticular n = 67	Polyarticular n = 9	Systemic n = 20	p-value
Age, years	12.4 ± 5.3	13.8 ± 7.5	10.9 ± 4.3	0.325
Age at diagnosis, years	9.0 ± 4.9	8.3 ± 4.6	8.7 ± 4.4	0.920
Age at disease onset, years	6.3 ± 3.1	6.6 ± 2.9	5.3 ± 3.5	0.574
BMI, kg/m2	17. 2 ± 3.4	17.5 ± 2 .7	16.4 ± 2.6	0.552
ANA positivity, n (%)	42 (62.7%)	4 (44.4%)	6 (30.0%)	0.301
RF positivity, n (%)	2 (3.0%)	2 (22.2%)	1 (5.0%)	0.115
HLA-B27 positivity, n (%)	10 (14.9%)	0	1 (5.0%)	0.245
Number of affected joints	3.2 ± 1.5	9.1 ± 4.3	5.5 ± 3.7	<0.001*

*Categorical variables were shown as number percentages. Numerical variables are mean (SD). * P-value <0.05 shows statistical significance. Post-hoc pairwise differences are indicated in bold in the table. Abbreviations: BMI, body mass index; JIA, juvenile idiopathic arthritis; ANA, antinuclear antibody; RF, rheumatoid factor; HLA-B27, human leukocyte antigen B27; SD, standard deviation.*

Table 4. Comparison of clinical and laboratory characteristics between patients with early and late radiological findings.

Variables	Early Findings n = 61	Late Findings n = 35	p-value
Age, years	11.8 ± 5.3	12.7 ± 5.4	0.445
Age at diagnosis, years	8.3 ± 3.8	9.2 ± 4.0	0.276
Age at disease onset, years	6.3 ± 3.3	5.8 ± 3.0	0.462
BMI, kg/m2	16.9 ±3.2	18.4 ± 3.2	0.118
ANA positivity, n (%)	38 (62.3%)	14 (40.0%)	0.034*
RF positivity, n (%)	3 (4.9%)	2 (5.7%)	0.856
HLA-B27 positivity, n (%)	4 (6.6%)	7 (20.0%)	0.049*
Extra-articular findings, n (%)	17 (27.9%)	24 (68.6%)	0.001*
Number of affected joints (mean ± SD)	4.2 ± 2.7	5.6 ± 3.6	0.033*
Time to diagnosis, years	2.0 ± 1.8	3.3 ± 2.0	0.002*

*Categorical variables were shown as number percentages. Numerical variables are mean (SD). * P-value <0.05 shows statistical significance. Abbreviations: ANA, antinuclear antibody; RF, rheumatoid factor; HLA-B27, human leukocyte antigen B27; SD, standard deviation.*

Discussion

This study evaluated the association of selected clinical, laboratory, and imaging-related factors with late radiological changes in children with JIA. Patients with late radiological changes had longer diagnostic delay, higher HLA-B27 positivity, more extra-articular findings, and greater joint involvement than those with early radiological changes. Notably, HLA-B27 positivity emerged as one of the most prominent features associated with late radiological changes, supporting its potential relevance in identifying children at higher risk for structural progression. ANA positivity, on the other hand, was more frequent in the early radiological group and may reflect underlying serologic and phenotypic heterogeneity within JIA [18-21].

Diagnostic delay continues to be a persistent difficulty in JIA management and has been consistently linked to poor long-term outcomes in children with the disease. Numerous studies have indicated that longer diagnosis time is associated with higher risk of radiological progression, increased joint damage, and poorer functional status [22-25]. Our findings are consistent with previous reports, with patients who exhibit late radiological features having a much greater diagnostic delay than those with early features. It is also noteworthy that diagnostic delays of over six months have been shown to heighten the risk of erosive joint disease and osteopenia, and therefore the need for early recognition and referral in children is stressed [23, 26]. Socioeconomic, demographic, and clinical characteristics may all influence diagnostic timing, and earlier recognition of at-risk children continues to be an important objective [27, 28]. Although our retrospective study design precludes the making of firm conclusions regarding causality, the demonstrated association serves to reinforce the continued need for enhanced awareness and expedited referral mechanisms in clinical practice to reduce the effects of diagnostic delays on long-term musculoskeletal outcomes in JIA.

HLA-B27 positivity has been known for some time to be a significant determinant in some subtypes of JIA, including enthesitis-related arthritis and juvenile spondyloarthritis, where it is linked to more severe disease phenotypes and a greater risk of axial involvement [20, 29, 30]. Previous investigations have shown that HLA-B27 is associated with a more chronic disease course, greater probability of sacroiliitis, and increased likelihood of radiological progression, particularly in patients monitored over long durations [22, 30-32]. In our patient cohort, HLA-B27 positivity was seen more commonly in patients with late radiological changes, raising the possibility that this genetic marker can aid in identifying children at greater risk for structural joint damage in the long term. However, it needs to be noted that not all HLA-B27 positive patients have adverse outcomes, and the influence of HLA-B27 may be further modulated by other clinical factors, including diagnostic delay and distribution of JIA subtypes [29, 32]. Therefore, while HLA-B27 testing can be useful for risk stratification, it must be interpreted in the context of thorough clinical and laboratory evaluation to inform management decisions. Prospective studies in the future are necessary to better delineate the prognostic role of HLA-B27 in heterogeneous JIA populations [29, 32, 33].

More recent literature has emphasized the heterogeneity of serological and clinical characteristics in JIA and their

importance for disease prognosis. ANA positivity, for instance, is more frequently found in oligoarticular subtypes and has been linked to reduced likelihood of severe joint damage and specific extra-articular complications, although its exact prognostic meaning is still controversial [3, 25]. Conversely, greater numbers of affected joints at diagnosis and the occurrence of extra-articular symptoms, including uveitis or enthesitis, have been connected with more severe disease courses and greater probabilities of radiological progression [29, 33, 34]. Our observations are consistent with these findings, in that patients with late radiological changes also had increased numbers of involved joints and more frequent extra-articular features, whereas ANA positivity was inversely related to late radiological progression. The inverse association between ANA positivity and late radiological changes in our cohort may reflect the greater representation of ANA-positive oligoarticular phenotypes, which may follow a different structural disease course than HLA-B27-associated or more extensive forms of JIA. However, this interpretation remains tentative and should be confirmed in prospective studies with subtype-specific analyses. Current research continues to investigate the potential of novel biomarkers and imaging techniques to further optimize prognostication and management approaches in pediatric rheumatology [25, 34-36].

The landscape of JIA therapy has been altered by advances in both biologic and traditional therapies, with consequent improvements in disease control and functional outcomes for a majority of patients. Methotrexate remains the anchor of therapy for polyarticular or prolonged JIA, while biologic medications, such as TNF inhibitors, have demonstrated dramatic efficacy in those cases that are either refractory or severe [37-39]. Recent research highlights that early intensification of therapy, based on the individual risk profile, can potentially limit the long-term burden of joint damage and disability [25, 36]. In our study, all the patients were given non-steroidal anti-inflammatory drugs, and a considerable proportion needed methotrexate or biologic drugs. However, late radiological changes were still evident in those with delays in diagnosis or those with higher-risk clinical features, reflecting the limitations of treatment when such changes are irreversible. These findings serve to stress the need for early diagnosis and for individualized treatment approaches, as well as for regular reassessment of therapeutic effectiveness in order to optimize outcomes in JIA. Clinical trials and real-world experience will continue to influence best practices, including the choice, sequence, and monitoring of therapies in pediatric rheumatology [25, 29, 36].

This study has certain limitations. Our findings may not be as broadly applicable as they could be due to selection bias caused by the retrospective and single-center design. In addition, the retrospective classification of some patients with features compatible with enthesitis-related arthritis may have influenced subtype-specific interpretation, particularly with respect to HLA-B27-associated findings. Furthermore, treatment modalities were summarized descriptively for the overall cohort and were not comparatively analyzed between patients with early and late radiological changes. It was not possible to conduct a systematic evaluation of some of the confounding factors, including socioeconomic status and environmental exposures. The differences in the imaging methods and the follow-up durations may have made it harder to pick up on extra-articular symptoms or joint damage. In addition, the relatively small size of the polyarticular subgroup may have limited the interpretability and statistical stability of subtype-based comparisons. Another limitation is the lack of a standardized imaging assessment protocol, as the retrospective dataset included ultrasonography and/or magnetic resonance imaging records obtained in routine clinical practice. Possible heterogeneity between imaging modalities may have affected the classification of findings as early or late radiological changes. Moreover, because the study data were collected between 2006 and 2015, current treatment strategies and imaging practices in JIA may differ from those applied during the study period. Notwithstanding these limitations, our study shows the importance of early identification of patients at high risk and their individualized treatment. It also offers us useful insights into the determinants of JIA progression on X-rays. Given the retrospective single-center design and the absence of multivariable analysis, these findings should be interpreted as associative rather than predictive or causal.

Conclusions

Diagnostic delay and HLA-B27 positivity were associated with late radiological changes in this study of children with JIA. These results highlight the need for early diagnosis and personalized monitoring strategies in pediatric rheumatology. Additional prospective multicenter studies are required for further risk stratification and long-term outcome optimization in this group of patients.

Declarations

This manuscript is derived from the master's thesis entitled "Evaluation of the Disease and Related Radiological Findings in Children with Juvenile Idiopathic Arthritis," prepared under

the supervision of Prof. Dr. Muferet Erguven at Istanbul Medeniyet University Goztepe Training and Research Hospital, İstanbul, Turkey, in 2015.

Ethics Committee Approval

The study was approved by the İstanbul Medeniyet University Goztepe Training and Research Hospital Ethics Committee, Approval No: 2015/0028; Date: April 21, 2015.

Informed Consent

The need for informed consent was waived under the approval of the Local Ethics Committee due to the retrospective design.

Data availability statement

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflicts of Interest

The authors declare they have no conflicts of interest.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

Conceptualization, M. Ertekin and M. Erguven; methodology, M. Ertekin and M. Erguven; validation, M. Ertekin and M. Erguven; formal analysis, M. Ertekin and M. Erguven; investigation, M. Ertekin and M. Erguven; resources, M. Ertekin and M. Erguven; data curation, M. Ertekin and M. Erguven; supervision, M. Erguven; writing—original draft preparation, M. Ertekin; writing—review and editing, M. Erguven. All authors have read and agreed to the published version of the manuscript.

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