Original Article

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Quick Response Code:

Website: www.ijhonline.org

DOI: 10.4103/ijh.ijh_21_22

The frequency of HLA A, B, C, DP, DQ, DR allele in patients of Turkish and Syrian nationals with allogeneic stem cell transplantation

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Abstract:

BACKGROUND: In allogeneic stem cell transplantation, donor and recipient HLA tissue compatibility is essential for the success of stem cell transplantation. HLA tissue compatibility percentage is the most important parameter that increases the success of transplantation in donor selection. Pretransplant HLA tissue typing can be looked at in low and high resolution according to the facilities of the center and the urgency of transplantation. Many centers evaluate HLA HLA-A, B, C, DP, DQ, DR tissue types before allogeneic bone marrow transplantation. HLA tissue types differ in many races and even between unrelated individuals of the same race.

AIMS: This study aimed to show the common human leukocyte antigen (HLA) rates and differences in Syrian and Turkish ethnicity patients who underwent allogeneic stem cell transplantation in our center.

MATERIALS AND METHODS: HLA tissue similarities between Turkish and Syrian patients were revealed by examining the HLA tissue records of Turkish and Syrian patients who applied to the bone marrow transplant unit of Inonu University Turgut Ozal Medical Center between December 2009 and November 2021 for allogeneic stem cell transplantation.

RESULTS: As a result of our study, it has been observed that there are similarities in terms of HLA A*02, HLA B*35, HLA C 04,07,12, HLA DP*02,04,11 HLA DQ*02,03,05,06, HLA DR*01,03,11,13 in Turkish and Syrian patients. High resolution HLA subgroups of the patients are shown in Tables three and four.

CONCLUSION: In allogeneic stem cell transplantation, there may be similar HLA tissue types among ethnic groups.

Keywords:

Allogeneic stem cell transplantation, ethnicity, human leukocyte antigen tissue types

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Submission: 30-04-2022
Revised: 28-05-2022
Accepted: 30-05-2022
Published: 25-10-2022

Introduction

Allogeneic stem cell transplantation may be curative for many hematological malignancies and nonmalignant diseases.[1] Although stem cell transplantation is widely used today, initial studies have shown that allogeneic stem cell transplantation also yields better results when donors are fully matched to the recipient at human leukocyte antigen (HLA) loci on both copies of chromosome 6.[1] However, only one-third of patients have an HLA-matched sibling donor, and shrinking family sizes in many societies further reduce this possibility.[2] "Major histocompatibility complex (MHC)" is a term used to describe a group of genes that encode a variety of cell surface markers, antigen-presenting molecules, and other proteins involved in immune function in

How to cite this article: Kaya A, Erkurt MA, Kuku İ, Kaya E, Berber İ, Biçim S, *et al*. The frequency of HLA A, B, C, DP, DQ, DR allele in patients of Turkish and Syrian nationals with allogeneic stem cell transplantation. Iraqi J Hematol 2022;11:110-7.

animals and humans. HLA complex is synonymous with human MHC. The MHC in humans refers to a genetic region containing hundreds of genes, including the HLA genes. Therefore, the human MHC region is also called the HLA region.[3] HLA genes express their gene products on the surface of white blood cells, hence the name "HLA," but HLA class I genes are expressed in all nucleated cells and are recognized as genes encoding "tissue antigens" or "tissue types." The function of these genes is factor responsible for the rejection of tissue grafts among mismatched individuals.[4] The HLA region is located at position 6p21.3 on the short arm of chromosome 6. The HLA region is divided into three regions: Class I, Class II, and Class III. Each region contains multiple gene loci, including expressed genes and pseudogenes. Some HLA loci are highly polymorphic, for example, over 6500 alleles are known for HLA-B and over 2500 alleles for HLA-DRB1.[5] The class I region contains the genes encoding the "classic" class I HLA antigens: HLA-A, B, and C. Class I antigens are expressed at varying rates in almost all cells of the body except erythrocytes and trophoblasts.[6] Class II region contains genes encoding HLA class II molecules, HLA-DP, DQ, and DR. Class II molecules are constitutively expressed on antigen-presenting cells (APC; e.g., dendritic cells, macrophages, or B cells) and can be induced during inflammation in many other cell types that normally have little or no expression. Each of the HLA-DQ and-DP proteins has polymorphic alpha and beta chains, which can be dimerized in various combinations, In contrast, all of the HLA-DR dimers share an essentially invariant alpha chain, while the beta chain is characterized by extreme polymorphism of these antigens.[7] The zone between class I and class II is known as class III zone. Although this region does not contain any of the HLA genes, it contains many genes important in the immune response, of which several examples are given below. Some examples of genetic relationships within the class III region with diseases such as SLE and RA are mentioned.[8,9] As the technology for genotyping HLA genes has improved over the years, so has the naming of the different alleles in individual HLA genes. As advances have been made in the understanding of HLA polymorphism, the terminology has been frequently revised.[10] Next-generation DNA-based typing (next-generation sequencing [NGS]) refers to sequencing technologies that enable the parallel sequencing of millions of short DNA fragments. NGS can be applied to sequence an entire genome or a targeted region of the genome. NGS has proven itself as the method of choice for HLA typing in many laboratories.[11] NGS method was used for tissue typing of the patients included in our study. Classic MHC spans 3.6 megabases and contains more than 200 genes, including genes of the immune system, with no known immune function. The exact structure and gene map of the HLA region are known.[12,13] HLA may show genetic polymorphism across ethnicities. DRB1 * 14:01 and 14:54 some data are currently available showing that the relative frequencies of alleles vary greatly between populations. DRB1 * 14:01 It is quite rare in Asian–American populations but more common in Spanish-speaking American populations.[14] In Europe, a recent study of 106 German donors with uncertain typings DRB1 * 14:01/14:54 found that 87.9% to be DRB1 * 14:54.[15] In our study, we tried to reveal the common HLA ratios and differences in Syrian and Turkish ethnicity patients who underwent allogeneic stem cell transplantation in our center.

Materials and Methods

In our study, tissue typing result forms of 45 Turkish, 11 Syrian patients who had allogeneic stem cell transplantation in the bone marrow transplant unit of our center between December 2009 and November 2021, were reviewed retrospectively through NGS Method (Miafora MFlex 6 loci PCR kits/Immucor Medizinische Diagnostik gmbh/Germany), using molecular high-resolution and low-resolution sequence-specific oligonucleotide (SSO) Method (Lifecodes HLA A, B, C, DRB1, DQA1/B1 eRES SSO typing kit/Immucor Medizinische Diagnostik gmbh/Germany) HLA-A, B, C, DP, DQ, DR allele pairs of the patients were recorded. Descriptive research type, total population sampling method was used in the study.[16] All patients admitted to Malatya Turgut Özal Medical Center bone marrow transplant unit for allogeneic stem cell transplantation between December 2009 and November 2021 were included in the study. Allele groups were compared and the same groups of alleles were added together and expressed as a percentage. The study was approved by Inonu University Ethics Committee (Number of decisions: 2022/3117).

Results

The study included 28 male and 11 female of Turkish nationals with a mean age of 45.13 ± 15.61 years and also 8 male and 3 female of Syrian nationals with a mean age of 31.36 ± 8.91 years. Twenty-one Turkish patients and 1 Syrian patient with acute myeloid leukemia, 12 Turkish patients and 4 Syrian patients with acute lymphocytic leukemia, 1 Turkish and 3 Syrian patients with non-Hodgkin's lymphoma, 2 Turkish patients with Hodgkin's lymphoma, 1 Turkish and 1 Syrian patient with aplastic anemia, 1 Turkish patients with beta-thalassemia, 1 Turkish patient with chronic lymphocytic leukemia, 1 Syrian patient with chronic myeloid leukemia, 2 Turkish patients with multiple myeloma, 2 patients with myelodysplastic, and 2 patients with primary myelofibrosis were included [Table 1].

Table 1: Demographic data of patients

	Nationality	
	Turkish, *n* (%)	Syrian, *n* (%)
Age (mean±SD)	45.13±15.61	31.36±8.91
Sex		
Male	28 (62.22)	8 (72.73)
Female	17 (37.78)	3 (27.27)
Diagnosis		
AML	21 (46.67)	1 (9.09)
ALL	12 (26.67)	4 (36.36)
Non-Hodgkin's lymphoma	1 (2.22)	3 (27.27)
Hodgkin's lymphoma	2 (4.44)	1 (9.09)
Aplastic anemia	1 (2.22)	1 (9.09)
Beta thalassemia	1 (2.22)	0
Chronic lenfositic losemia	1 (2.22)	0
Chronic myeloid leukemia	0	1 (9.09)
Multiple myeloma	2 (4.44)	0
Myelodisplastic	2 (4.44)	0
Primer myelofibrrozis	2 (4.44)	0

SD=Standard deviation, AML=Acute myeloid leukemia, ALL=Acute lymphocytic leukemia

01, 02, 03, 24 allele is the most common in low-resolution HLA-A tissue typing in Turks. 02, 03, 11, 26, 30 allele is the most common in low-resolution HLA-A tissue typing in Syria. HLA-A*02 allele is possible more frequently in Turkish and Syrian patients. 35, 51, 55 allele is the most common in low-resolution HLA-B tissue typing in Turks. 8, 27, 35, 38 allele is the most common in low-resolution HLA-B tissue typing in Syria. HLA-B*35 allele is possible more frequently in Turkish and Syrian patients. 01, 04, 07, 12, 16 allele is the most common in low-resolution HLA-C tissue typing in Turks. 02, 04, 07, 12 allele is the most common in low-resolution HLA-C tissue typing in Syria. HLA-C 04, 07, 12 allele are similar in Turkish and Syrian patients. 02, 04, 11, 14 allele is the most common in low-resolution HLA-DP tissue typing in Turks. 02, 04, 11, 104 allele is the most common in low-resolution HLA-DP tissue typing in Syria. HLA-DP*02, 04, 11 allele is possible more frequently in Turkish and Syrian patients. 02, 03, 05, 06 allele is the most common in low-resolution HLA-DQ tissue typing in Turks. 02, 03, 05, 06 allele is the most common in low-resolution HLA-DQ tissue typing in Syria. HLA-DQ*02, 03, 05, 06 allele is possible more frequently in Turkish and Syrian patients. 01, 03, 04, 11, 13, 15, 16 allele is the most common in low-resolution HLA-DR tissue typing in Turks. 01, 03, 11, 13 allele is the most common allele in low-resolution HLA-DR tissue typing in Syria. HLA-DR*01, 03, 11, 13 allele is possible more frequently in Turkish and Syrian patients [Table 2].

When both alleles were added, the distribution of high-resolution HLA-A*02:01 in Turks and Syrian patients was found as 23.68% in Turks and 30% in Syrian patients. The distribution of HLA-A*02:05 in Turks and Syrian patients was found to be 10.52% in Turks and 10% in Syrian patients when both alleles were added. Distribution percentages of other alleles are shown in Table 3. The distribution of HLA-B*35:01 in Turks and Syrian patients was found to be 5.26% in Turks and 50% in Syrian patients when both alleles were added. The distribution of HLA-B*35:02 in Turks and Syrian patients was found to be 15.79% in Turks and 0% in Syrian patients when both alleles were added. The distribution of HLA-B*35:03 in Turks and Syrian patients was found to be 10.52% in Turks and 0% in Syrian patients when both alleles were added. The distribution of HLA-B*35:08 in Turks and Syrian patients was found to be 5.26% in Turks and 0% in Syrian patients when both alleles were added. The distribution of HLA-C*04:01 in Turks and Syrian patients was found to be 36.85% in Turks and 50% in Syrian patients when both alleles were added. The distribution of HLA-C*07:01 in Turks and Syrian patients was found to be 10.52% in Turks and 30% in Syrian patients when both alleles were added. The distribution of HLA-C*07:02 in Turks and Syrian patients was found to be 15.79% in Turks and 0% in Syrian patients when both alleles were added. The distribution of HLA-C*07:04 in Turkish and Syrian patients was 2.63% in Turks and 0% in Syrian patients when both alleles were added. The distribution of HLA-C*07:18 in Turkish and Syrian patients was found to be 0% in Turks and 20% in Syrian patients when both alleles were added. The distribution of HLA-C*12:02 in Turks and Syrian patients was found to be 15.78% in Turks and 0% in Syrian patients when both alleles were added. The distribution of HLA-C*12:03 in Turks and Syrian patients was found to be 21.05% in Turks and 20% in Syrian patients when both alleles were added [Table 3].

The distribution of HLA-DPB1 * 02:01 in Turks and Syrian patients was found to be 39.44% in Turks and 50% in Syrian patients when both alleles were added. HLA-DP B1 * 04:01 the distribution in Turks and Syrian patients was found to be 78.95% in Turks and 60% in Syrian patients when both alleles were added. HLA-DP B1 * 04:02 the distribution in Turks and Syrian patients was found to be 28.95% in Turks and 20% in Syrian patients when both alleles were added. The distribution of HLA-DPB1 * 11:01 in Turks and Syrian patients was found to be 2.6% in Turks and 10% in Syrian patients when both alleles were added. The distribution of HLA-DPB1 * 11:01 in Turks and Syrian patients was found to be 2.6% in Turks and 10% in Syrian patients when both alleles were added. The distribution of HLA-DQB1 * 02:01 in Turks and Syrian patients was found to be 18.42% in Turks and 50% in Syrian patients when both alleles were added. HLA-DQB1 * 02:02 the distribution in Turks and Syrian patients was found to be 0% in Turks and 10% in Syrian patients when both alleles were added. HLA-DQB1 * 03:01 the distribution in Turks and Syrian patients was 50% in Turks and 50% in Syrian patients when both alleles were added. HLA-DQB1 * 03:02 the

Table 2: Low-resolution distribution of human leukocyte antigen A, B, C, DP-B1, DQ-B1, DR-B1 alleles

HLA-A	Nationality		HLA-B	Nationality		HLA-C	Nationality		HLA-DP-B1	Nationality		HLA-DQ-B1	Nationality		HLA-DR-B1	Nationality	
	Turkish, *n* (%)	Syrian, *n* (%)		Turkish, *n* (%)	Syrian, *n* (%)		Turkish, *n* (%)	Syrian, *n* (%)		Turkish, *n* (%)	Syrian, *n* (%)		Turkish, *n* (%)	Syrian, *n* (%)		Turkish, *n* (%)	Syrian, *n* (%)
01	11 (12.22)	1 (4.55)	07	4 (4.44)	1 (4.55)	01	6 (6.67)	1 (4.55)	01	1 (1.11)	0	02	11 (12.22)	7 (31.82)	01	6 (7.89)	8 (44.44)
02	18 (20.00)	4 (18.18)	08	4 (4.44)	3 (13.64)	02	2 (2.22)	3 (13.64)	02	15 (16.67)	5 (22.73)	03	41 (45.56)	6 (27.27)	02	0	1 (5.56)
03	14 (15.56)	3 (13.64)	13	2 (2.22)	0	03	2 (2.22)	1 (4.55)	03	5 (5.56)	1 (4.55)	04	3 (3.33)	0	03	7 (9.21)	4 (22.22)
11	3 (3.33)	3 (13.64)	14	1 (1.11)	0	04	18 (20.00)	5 (22.73)	04	42 (46.67)	8 (36.36)	05	20 (22.22)	4 (18.18)	04	15 (19.74)	0
23	1 (1.11)	1 (4.55)	15	3 (3.33)	1 (4.55)	05	1 (1.11)	0	05	2 (2.22)	0	06	15 (16.67)	5 (22.73)	07	1 (1.32)	1 (5.56)
24	18 (20.00)	1 (4.55)	18	4 (4.44)	0	06	7 (7.78)	2 (9.09)	07	1 (1.11)	1 (4.55)				08	5 (6.58)	0
26	5 (5.56)	3 (13.64)	27	0	3 (13.64)	07	14 (15.56)	7 (31.82)	09	2 (2.22)	0				09	1 (1.32)	0
29	1 (1.11)	0	35	20 (22.22)	7 (31.82)	08	1 (1.11)	0	11	6 (6.67)	2 (9.09)				11	14 (18.42)	2 (11.11)
30	3 (3.33)	3 (13.64)	38	4 (4.44)	2 (9.09)	12	16 (17.78)	2 (9.09)	13	3 (3.33)	1 (4.55)				13	8 (10.53)	2 (11.11)
31	2 (2.22)	0	39	3 (3.33)	0	14	4 (4.44)	0	14	8 (8.89)	1 (4.55)				14	3 (3.95)	0
32	3 (3.33)	0	40	1 (1.11)	1 (4.55)	15	3 (3.33)	0	16	1 (1.11)	0				15	9 (11.84)	0
33	3 (3.33)	1 (4.55)	41	2 (2.22)	0	16	14 (15.56)	0	17	0	1 (4.55)				16	7 (9.21)	0
66	2 (2.22)	1 (4.55)	44	7 (7.78)	1 (4.55)	17	2 (2.22)	1 (4.55)	26	1 (1.11)	0						
68	6 (6.67)	1 (4.55)	47	1 (1.11)	0				88	1 (1.11)	0						
			49	1 (1.11)	1 (4.55)				104	1 (1.11)	2 (9.09)						
			50	2 (2.22)	0				105	1 (1.11)	0						
			51	17 (18.89)	0												
			52	6 (6.67)	0												
			53	0	1 (4.55)												
			55	7 (7.78)	0												
			57	1 (1.11)	0												
			58	0	1 (4.55)												

HLA=Human leukocyte antigen

Table 3: High-resolution distribution of human leukocyte antigen A, B, C allele pairs

HLA-A1 allele	Nationality		HLA-A 2 allele	Nationality		HLA-B 1 allele	Nationality		HLA-B 2 allele	Nationality		HLA-C 1 allele	Nationality		HLA-C 2 allele	Nationality	
	Turkish, *n* (%)	Syrian, *n* (%)		Turkish, *n* (%)	Syrian, *n* (%)		Turkish, *n* (%)	Syrian, *n* (%)		Turkish, *n* (%)	Syrian, *n* (%)		Turkish, *n* (%)	Syrian, *n* (%)		Turkish, *n* (%)	Syrian, *n* (%)
01:01	10 (26.32)	1 (10)	02:01	3 (7.89)	1 (10)	07:02	1 (2.63)	0	08:01	0	1 (10)	01:02	5 (13.16)	0	01:02	1 (2.63)	0
02:01	8 (21.05)	3 (30)	02:22	1 (2.63)	0	08:01	4 (10.53)	2 (20)	15:17	1 (2.63)	0	01:17	0	1 (10)	02:02	0	1 (10)
02:05	2 (5.26)	0	03:01	2 (5.26)	1 (10)	14:01	1 (2.63)	0	18:01	1 (2.63)	0	02:02	2 (5.26)	2 (20)	04:01	4 (10.53)	2 (20)
03:01	3 (7.89)	2 (20)	03:02	3 (7.89)	0	15:01	1 (2.63)	0	27:03	0	1 (10)	03:02	0	1 (10)	05:01	1 (2.63)	0
03:02	4 (10.53)	0	24:02	10 (26.32)	1 (10)	15:17	0	1 (10)	35:01	4 (10.53)	1 (10)	03:03	2 (5.26)	0	06:02	1 (2.63)	1 (10)
11:01	2 (5.26)	2 (20)	24:03	1 (2.63)	0	15:18	1 (2.63)	0	35:03	1 (2.63)	1 (10)	04:01	10 (26.32)	3 (30)	07:01	1 (2.63)	3 (30)
23:01	1 (2.63)	1 (10)	26:01	4 (10.53)	3 (30)	18:01	3 (7.89)	0	38:01	0	1 (10)	06:02	4 (10.53)	1 (10)	07:02	5 (13.16)	0
24:02	4 (10.53)	0	30:01	0	1 (10)	27:02	0	1 (10)	39:01	1 (2.63)	0	07:01	3 (7.89)	0	07:18	0	1 (10)
29:02	1 (2.63)	0	30:02	0	1 (10)	27:03	0	1 (10)	40:06	0	1 (10)	07:02	1 (2.63)	0	08:02	1 (2.63)	0
30:02	0	1 (10)	30:04	1 (2.63)	0	35:01	1 (2.63)	4 (40)	41:01	1 (2.63)	1 (10)	07:04	1 (2.63)	0	12:02	3 (7.89)	0
31:01	2 (5.26)	0	32:01	3 (7.89)	0	35:02	4 (10.53)	0	44:02	2 (5.26)	0	07:18	0	1 (10)	12:03	5 (13.16)	1 (10)
68:01	1 (2.63)	0	33:01	1 (2.63)	0	35:03	3 (7.89)	0	44:03	1 (2.63)	0	12:02	3 (7.89)	0	14:02	1 (2.63)	0
			33:03	2 (5.26)	0	35:08	1 (2.63)	0	47:01	1 (2.63)	0	12:03	3 (7.89)	1 (10)	14:03	1 (2.63)	0
			66:01	2 (5.26)	1 (10)	38:01	3 (7.89)	1 (10)	49:01	0	1 (10)	14:02	2 (5.26)	0	15:02	2 (5.26)	0
			68:01	5 (13.16)	0	39:01	1 (2.63)	0	50:01	2 (5.26)	0	16:02	1 (2.63)	0	16:02	6 (15.79)	0
			68:02	0	1 (10)	39:31	1 (2.63)	0	51:01	10 (26.32)	0	16:04	1 (2.63)	0	16:04	4 (10.53)	0
						40:02	1 (2.63)	0	51:08	1 (2.63)	0				17:01	2 (5.26)	1 (10)
						41:01	1 (2.63)	0	52:01	5 (13.16)	0						
						44:02	3 (7.89)	0	53:01	0	1 (10)						
						44:03	1 (2.63)	0	55:01	6 (15.79)	0						
						49:01	1 (2.63)	0	57:01	1 (2.63)	0						
						51:01	4 (10.53)	0	58:01	0	1 (10)						
						52:01	1 (2.63)	0									
						55:01	1 (2.63)	0									

HLA=Human leukocyte antigen

distribution in Turks and Syrian patients was found to be 26.31% in Turks and 0% in Syrian patients when both alleles were added. HLA-DQB1 * 03:03 the distribution in Turks and Syrian patients was found to be 5.26% in Turks and 10% in Syrian patients when both alleles were added. The distribution of HLA-DQB1 * 05:01 in Turks and Syrian patients was found to be 15.79% in Turks and 0% in Syrian patients when both alleles were added. The distribution of HLA-DQB1 * 05:02 in Turks and Syrian patients was found to be 26.31% in Turks and 10% in Syrian patients when both alleles were added. The distribution of HLA-DQ B1 * 06:01 in Turks and Syrian patients was found to be 18.42% in Turks and 10% in Syrian patients when both alleles were added. HLA-DQ B1 * 06:03 the distribution in Turks and Syrian patients was found to be 15.79% in Turks and 20% in Syrian patients when both alleles were added. The distribution of HLA-DR B1 * 01:01 in Turks and Syrian patients was found to be 13.16% in Turks and 0% in Syrian patients when both alleles were added. The distribution of HLA-DR B1 * 01:0 in Turks and Syrian patients was found to be 2.63% in Turks and 0% in Syrian patients when both alleles were added. The distribution of HLA-DR B1 * 03:0 in Turks and Syrian patients was found to be 18.42% in Turks and 44.44% in Syrian patients when both alleles were added. The distribution of HLA-DR B1 * 11:01 in Turks and Syrian patients was found to be 5.2% in Turks and 44.44% in Syrian patients when both alleles were added. The distribution of HLA-DR B1 * 11:03 in Turks and Syrian patients was found to be 2.63% in Turks and 0% in Syrian patients when both alleles were added. The distribution of HLA-DR B1 * 11:04 in Turks and Syrian patients was found to be 28.95% in Turks and 0% in Syrian patients when both alleles were added. The distribution of HLA-DR B1 * 13:01 in Turks and Syrian patients was found to be 15.79% in Turks and 22.22% in Syrian patients when both alleles were added. The distribution of HLA-DR B1 * 13:02 in Turks and Syrian patients was found as 2.63% in Turks and 22.22% in Syrian patients when both alleles were added. Another allele distribution of the patients is available in Table 4.

Discussion

HLA complex is synonymous with human major tissue compatibility complex (MHC). These terms describe a group of genes on chromosome 6 that encode various cell surface markers, antigen-presenting molecules, and other proteins; many are related to immune function, but the role of many other genes in this genetic region in immune function is unknown.[6] In the study by Niens *et al*., it was thought that HLA-A*02 could present EBV-derived peptides and evoke an effective immune response that creates a protective phenotype.[17] In our study, HLA-A*02 allele was seen more frequently in Syrian and Turkish patients. Our patients are screened for EBV with routine serological tests in our center before stem cell transplantation, and patients with negative screening results are taken for bone marrow transplantation. In the study of Shahsavar *et al*., HLA-B alleles * 35 were found to be 24% of the Lak population in Iran.[18] In our study, 22.22% in low-resolution Turks and 31.52% in Syrian patients. High-resolution HLA-B *35 allele subsets are shown in Table 3. In the study of Burmistrova *et al*., in Russians living in the Chelyabinsk region, the most common allele was HLA-DPB1 * 04:01, other common HLA-DPB1 alleles were; DPB1 * 04:02, DPB1 * 02:01, DPB1 * 03:01.[19] In our study, HLA-DPB1 02,04,14 was observed most frequently in low-resolution Syrian and Turkish patients, the distribution of other alleles is shown in Table 3. The high-resolution distribution of the HLA-DPB1 02, 04, 14 alleles is shown in Table 4. In the study of Ilonen *et al*. in Finland, HLA-DQB1 * 02 and DQB1 * 0301 were more common in the Turkuda region and DQB1 * 0302 in Ouluda region.[20] In our study, HLA-DQ*02,03,05,06 alleles were seen more frequently in Turkish and Syrian patients who underwent allogeneic stem cell transplantation. Other low-resolution allele distributions are shown in Table 2. High-resolution allele distribution is shown in Table 4. According to the study of Azira *et al*., in the study of Malays from the Malaysian population, HLA DR12 and HLA DQ8 were found to be the most common HLA class II type.[21] In our study, in low-resolution screening tissue typing, HLA-DR*01, 03, 11, 13 are the most common alleles in Turkish and Syrian patients. The distribution of other low-resolution alleles is shown in Table 2. HLA-DR high-resolution distribution is shown in Table 4. The most common allele groups in the study of Kirijas *et al*. are HLA-A*02 (29.0%), HLA-A*24 (13.8%), HLA-B*35 (16.1%), HLA-B*51 (14.7%), HLA-B*18 (14.7%), HLA-C*07 (27.9%), HLA-DRB1 * 11 (25.5%), and HLA-DRB1 * 16 (14.8%).[22] In our study, HLA-A*02, HLA-B*35, HLA-C*02.04.07, HLA-DP 02.04.11, HLA-DQ 02.03.05.06, HLA-DRB1 * 02.04,11 were found most frequently in Turks and Syrian patients. Percentages are shown in Table 2. In the study of Tshabalala *et al*. in the South African bone marrow records, the most common alleles were A * 02:02, B * 07:02, C * 07:02, DQB1 * 06:02, and DRB1 * 15:01.[23] In our study, A * 02:01 in Turks and Syrian patients, B08:01 in Syrians, B 18:01 in Turks, C 04:01 in Turks and Syrian patients, DP 04:01 in Turks and Syrian patients, DQ 03:01 in Turks and Syrian patients. DR 11:04 in Turks and DR 11:01 in Syrian patients are the most common allele groups, and the distribution of other allele groups is shown in Tables 3 and 4. In the study of Ad'hiah *et al*., HLA polymorphisms (A, B, DRB1, and DQB1 loci) were determined in Iraqi Arab potential bone marrow and kidney donors. HLA-A,-B and-DRB1 genotype frequencies deviated significantly from Hardy-Weinberg equilibrium, while HLA-DQB1 frequencies did not show any deviation. While A * 03, B

Table 4: High-resolution distribution of human leukocyte antigen DP-B1, DQ-B1, DR-B1 allele pairs

HLA-DP-B1 1 allele	Nationality		HLA-DP-B12 allele	Nationality		HLA-DQB1 1 allele	Nationality		HLA-DQB1 2 allele	Nationality		HLA-DRB1 1 allele	Nationality		HLA-DRB1 2 allele	Nationality	
	Turkish, *n* (%)	Syrian, *n* (%)		Turkish, *n* (%)	Syrian, *n* (%)		Turkish, *n* (%)	Syrian, *n* (%)		Turkish, *n* (%)	Syrian, *n* (%)		Turkish, *n* (%)	Syrian, *n* (%)		Turkish, *n* (%)	Syrian, *n* (%)
02:01	14 (36.84)	5 (50)	02:01	1 (2.63)	0	02:01	7 (18.42)	4 (40)	02:01	0	1 (10)	01:01	4 (10.53)	0	01:01	1 (2.63)	0
03:01	1 (2.63)	1 (10)	03:01	1 (2.63)	0	02:02	0	1 (10)	03:01	3 (7.89)	2 (20)	01:02	1 (2.63)	0	03:01	0	1 (11.11)
04:01	17 (44.74)	3 (30)	04:01	13 (34.21)	3 (30)	03:01	16 (42.11)	3 (30)	03:02	3 (7.89)	0	03:01	7 (18.42)	4 (44.44)	04:02	2 (5.26)	0
04:02	4 (10.53)	0	04:02	7 (18.42)	2 (20)	03:02	7 (18.42)	0	03:03	1 (2.63)	1 (10)	04:01	3 (7.89)	0	04:03	2 (5.26)	0
09:01	1 (2.63)	0	05:01	2 (5.26)	0	03:03	1 (2.63)	0	03:04	1 (2.63)	0	04:02	2 (5.26)	0	07:01	1 (2.63)	1 (11.11)
11:01	0	1 (10)	09:01	1 (2.63)	0	04:02	2 (5.26)	0	03:05	1 (2.63)	0	04:03	3 (7.89)	0	08:01	1 (2.63)	0
13:01	1 (2.63)	0	104:01	1 (2.63)	2 (20)	05:01	1 (2.63)	0	04:02	1 (2.63)	0	04:05	1 (2.63)	0	08:03	1 (2.63)	0
			105:01	1 (2.63)	0	05:02	1 (2.63)	0	05:01	5 (13.16)	0	04:07	2 (5.26)	0	11:01	1 (2.63)	2 (22.22)
			11:04	0	1 (10)	06:01	2 (5.26)	1 (10)	05:02	9 (23.68)	1 (10)	07:01	0	1 (11.11)	11:04	6 (15.79)	0
			13:01	2 (5.26)	1 (10)	06:03	1 (2.63)	1 (10)	05:03	2 (5.26)	2 (20)	08:01	2 (5.26)	0	13:01	5 (13.16)	1 (11.11)
			14:01	7 (18.42)	0				06:01	5 (13.16)	0	08:03	1 (2.63)	0	13:02	1 (2.63)	1 (11.11)
			17:01	0	1 (10)				06:02	1 (2.63)	0	09:01	1 (2.63)	0	13:03	1 (2.63)	0
			26:01	1 (2.63)	0				06:03	5 (13.16)	1 (10)	11:01	1 (2.63)	2 (22.22)	14:01	0	1 (11.11)
			88:01	1 (2.63)	0				06:04	1 (2.63)	2 (20)	11:03	1 (2.63)	0	14:04	0	1 (11.11)
												11:04	5 (13.16)	0	14:54	3 (7.89)	0
												13:01	1 (2.63)	1 (11.11)	15:01	1 (2.63)	1 (11.11)
												13:02	0	1 (11.11)	15:02	5 (13.16)	0
												15:01	1 (2.63)	0	15:06	1 (2.63)	0
												15:02	1 (2.63)	0	16:01	3 (7.89)	0
												16:01	1 (2.63)	0	16:02	3 (7.89)	0

HLA=Human leukocyte antigen

* 35, DRB1 * 11, and DQB1 * 02 were the most common allele groups, A * 02-B*07-DRB1 * 04-DQB1 * 03 was the most common haplotype.[24] In our study, HLA-A*02, HLA-B*35, HLA-C*02.04.07, HLA-DP 02.04.11, HLA-DQ 02.03.05.06, HLA-DRB1 * 02.04,11 were found most frequently in Turks and Syrian patients. Table 2 shows the percentages. High-resolution ratios of each pair of the same allele are available in Tables 3 and 4.

Conclusion

In allogeneic stem cell transplantation, there may be similar HLA tissue types among ethnic groups.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

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