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Seroprevalence of Human Parvovirus B19 in Symptomatic and Asymptomatic Cases

Semptomatik ve Asemptomatik Vakalarda İnsan Parvovirus B19 Seroprevalansı

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ABSTRACT

Aim: Parvovirus B19 (HPV B19) is a highly contagious virus that is usually transmitted through the respiratory tract. In this study, Parvovirus B19 antibodies were investigated in symptomatic and asymptomatic cases.

Material and method: A total of 221 patients were studied for HPV B19 antibodies using the ELISA method between 1998-2001. Findings were analyzed statistically.

Results: It was observed that seropositivity increased with age and peaked in groups over 16 years of age, while seronegativity peaked in the 0-5 age group. When the serological pattern was evaluated according to the clinical stage of the infection, it was observed that the frequency of acute infection was maximum in the 6-10 age group, and there was no acute infection in the control group. When the distribution of acute infection by age was examined, it was observed that anti-HPV B19-IgG positivity was minimum in the 0-5 age group and maximum in the group above 16 years old. In terms of the frequency of IgG positivity, there was a significant difference between the age group above 16 and the age group 6-10 ($p<0.05$). There was no statistically significant difference in terms of acute infection in the control group ($p>0.05$). Also, IgM positivity showed a significant difference according to age groups ($p >0.05$).

Results: According to our results, seropositivity for HPV B19, clinical-stage, acute infection frequency and IgG positivity increase with age. This infection should be kept in mind for optimal treatment management, especially in patients at risk after puberty.

Keywords: Parvovirus B19, seropositivity, age, IgG, IgM

ÖZ

Amaç: Parvovirus B19 (HPV B19), genellikle solunum yolu yoluyla bulaşan oldukça bulaşıcı bir virüstür. Bu çalışmada semptomatik ve asemptomatik olgularda Parvovirus B19 antikorları araştırıldı.

Gereç ve Yöntem: 1998-2001 yılları arasında ELISA yöntemi kullanılarak HPV B19 antikorları için toplam 221 hasta incelendi. Bulgular istatistiksel olarak analiz edildi.

Bulgular: Seropozitifliğin yaşla birlikte arttığı ve 16 yaş üstü gruplarda zirve yaptığı, 0-5 yaş grubunda ise seronegativitenin zirve yaptığı görüldü. Enfeksiyonun klinik evresine göre serolojik patern değerlendirildiğinde 6-10 yaş grubunda akut enfeksiyon sıklığının maksimum olduğu, kontrol grubunda akut enfeksiyon olmadığı görüldü. Akut enfeksiyonun yaşa göre dağılımı incelendiğinde anti-HPV B19-IgG pozitifliğinin 0-5 yaş grubunda minimum, 16 yaş üstü grupta maksimum olduğu görüldü. IgG pozitifliği sıklığı açısından 16 yaş üstü ile 6-10 yaş grubu arasında anlamlı fark vardı ($p<0.05$). Kontrol grubunda akut enfeksiyon açısından istatistiksel olarak anlamlı fark yoktu ($p>0.05$). Ayrıca IgM pozitifliği yaş gruplarına göre anlamlı farklılık gösterdi ($p>0.05$).

Bulgular: Sonuçlarımıza göre yaşla birlikte HPV B19 için seropozitiflik, klinik evre, akut enfeksiyon sıklığı ve IgG pozitifliği artmaktadır. Bu enfeksiyon, özellikle ergenlikten sonra risk altındaki hastalarda optimal tedavi yönetimi için akılda tutulmalıdır.

Anahtar Kelimeler: Parvovirus B19, seropozitiflik, yaş, IgG, IgM

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INTRODUCTION

Parvovirus B19 (HPV B19) a member of the parvoviridae family, is a highly contagious virus and is mostly spread through the respiratory system (1). Symptoms of HPV B19 infections are non-specific and laboratory tests are necessary to differentiate them from other infections (2,3). Parvovirus is mostly asymptomatic, but when it is symptomatic, it can have symptoms such as fever, myalgia, and rash (4). There are three factors that significantly increase the risk of acute HPV B19, namely having a chronic illness, having children at home, and working in a stressful job. IgM positivity for HPV B19 is associated with a pregnancy resulting in abortion (4,5).

Although there is no antiviral treatment available for HPV B19 today, recombinant vaccine studies are ongoing (6). In order to prevent the disease, it is recommended to distinguish people with chronic parvovirus and aplastic crisis from high-risk patients and to use gloves, gowns and masks for high-risk people (7,8). Symptomatic treatment is sufficient in most cases, but blood transfusion may be necessary for conditions such as aplastic crisis and hydrops fetalis. For example, while symptomatic improvement is provided in erythema infectiosum in terms of treatment, sometimes transfusion and haemoglobin are applied in an aplastic crisis, and intrauterine transfusion is applied in hydrops fetalis (8,9). For the treatment of immunocompromised patients, taking immunoglobulin from a normal donor is a preferred method (9). Information on HPV B19 is still limited in the literature, and more research is needed in large patient groups to clarify this issue.

The aim of this study is to investigate Parvovirus B19 antibodies in cases with and without clinical complaints.

MATERIAL AND METHOD

Ethical Situation

Approval was obtained from the non-invasive ethics committee for our study. All procedures in our study were conducted in accordance with the 1964 Helsinki declaration.

Patients Population

HPV B19 antibodies were investigated using the ELISA method in 221 patients with and without clinical symptoms between 1998-2001. The age of the cases ranged from 0 to 68 years. HPV B19 antibody was examined in 182 patients (102 men and 80 women) with clinical symptoms (such as bleeding diathesis, gastrointestinal, neurological and respiratory system problems, rash, nephritis, urinary infection) and 39 (12 men, 27 women) healthy persons. Serums were kept at -20°C until analysis. Anti HPV B19 IgM and IgG antibodies and commercial ELISA kits were used for analysis. The absorbance value of each serum was evaluated by spectrophotometry. Positive and negative reference sera were used, +/- 10% of cut-off values were considered equivocal and retested. Positive results for anti-HPV B19 IgG and/or IgM were considered seropositive and negative results were considered seronegative. Positive results for Ig M alone or in combination with IgG were considered an acute infection.

Statistical Analysis

For statistical analysis, the difference between Parvovirus B19 serological results of the patient and healthy groups was evaluated using the Pearson Chi-square test.

RESULTS

General Findings

Within the study group, it was found that 60.6 % was seropositive (Anti-HPV IgM and/or IgG positive) and 39.4% seronegative. Seropositivity was 61.6% in the asymptomatic group as 56.4% in the control group. When the results are evaluated according to seropositivity/negativity, it is found that 39.4% of all the working group is seropositive and 60.6% of is seronegative (**Table 1**).

Table 1. Serological profile of the people in the study group

Working group	Seronegativity %	Seropositivity %
Control (n=39)	43.6%	56.4%
Symptomatic (n=182)	38.4%	61.6%
Total (n=221)	39.4%	60.6%

When seropositive individuals were selected according to the disease period (acute or past infection), it was found that IgM positivity (acute infection) was 10.4% (23/221), and 50% (111/221) were only IgG positive (**Table 2**).

Table 2. Clinical reflection of HPV B19 infection according to serologic profile

	Seronegative		Seropositive				Total
	Unexposed with a factor		Acute infection		Past infection **		
	n	%	n	%	n	%	
Control group	17	43.6	0	0	22	56.4	139
Patient group	70	38.5	23	12.6	89	48.9	182
Total	87	39.4	23	10.4**	111	50.2***	221

Abbreviations: *IgG and IgM=negative, ** IgM=positive, IgG=negative or positive, ***IgG=positive

When evaluated according to seropositivity and seronegativity age groups, it is observed that seropositivity increases with age and reaches a peak above the 16 age groups and that seronegativity reaches a peak at 0-5 age group (**Table 3**)

Table 3. Distribution of Anti-HPV B19 antibodies according to age groups.

Age groups	Negative (%)	Pozitive (%)
0-5 (n=94)	52.1	47.9
6-10 (n=49)	42.8	52.8
11-15 (n=45)	26.6	73.4
16+ (n=33)	15.1	84.9
Total (n=221)	39.4	60.6

While the seronegativity and seropositivity rate in the symptomatic and control groups were similar in the whole study group, the seronegativity rate was 38.4% in the symptomatic group and 43.6% in the control group, and the seropositivity rates were 61.6% and 56.4%, respectively (**Table 4**).

Table 4. Distribution of anti-HPV B19 antibodies at the symptomatic and control group according to age groups

	Age		Anti-HPV B19 Ab Negative (%)	Anti-HPV B19 Ab Positive (%)
Symptomatic group n=182	0-5	n=83	50.6	49.4
	6-10	n=44	37.2	62.8
	11-15	n=41	24.4	75.6
	16+	n=14	7.2	92.8
	Total	n=182	38.4	61.6
Control group n=39	0-5	n=11	63.6	36.4
	6-10	n=5	83.3	16.7
	11-15	n=4	50	50
	16+	n=19	21	79
	Total	n=39	43.6	56.4

It was found that there was no acute HPV B19 infection in the control group and the rate of acute HPV B19 infection in the symptomatic group was 12.6% (**Table 5**)

Table 5. Frequency of acute HPV B 19 infection at the patient and control groups

	Anti-HPVB19 IgM Negative		Anti-HPVB19 IgM Positive		Total n
	n	%	n	%	
Control group	39	100	0	0	39
Patient group	159	87.4	23	12.6	182
total	198	89.6	23	10.4	221

When evaluated according to the clinical stage of serologic pattern infection, it is found that the frequency of acute infection is the maximum at the 6-10 age group and the frequency of past infection increases with the age. Profile of IgM (+) and IgG (-) or IgM (+) and IgG (-) is not found in the control group. In this way, while not found any acute infection in the control group, it is determined that past infection findings increase with the age. When evaluated according to age group, seropositivity was 16.7% between 0 and 6 years of age in the control group and 61.4% in the patient group.

The distribution of acute infection showed biphasic progression and the distribution seemed to be more common in the 6-10 age group and the age group over 16 years old. Anti HPV B19-IgG positivity was observed to be minimum in the 0-5 age group and maximum in the 16 age group. There was a significant difference in the prevalence of IgG positivity between the 16+ age group and the 6-10 age group ($p<0.05$). The frequency of past infections increased with increasing age. There was a statistically significant difference between the age groups (0-5 and 6-10) and (11-15 and 16+) ($p<0.05$) (**Table 6**).

Table 6. Frequency of HPV B19 infection according to clinical stage

Age	Seronegative*		Past infection **		Acute infection ***	
	n	%	n	%	n	%
0-5, n=94	49	52.1	35	32.7	10	10.6
6-10, n=49	21	42.8	19	38.8	9	18.4
11-15, n=45	12	26.6	32	71,1	1	2.2
16+, n=33	5	15.2	25	75.8	3	9
Total, n=221	87	39.4	111	50.2	23	10.4

Abbreviations: *IgM (-) and IgG (-), ** IgM (+) and IgG (+), *** IgM (+) and IgG (+) or (-)

The frequency of acute HPV B19 in the symptomatic group was found to be 12.6%. There was no statistically significant difference in acute infection in the control group ($p>0.05$). Although IgM positivity was found to has a difference according to the age groups, this difference was statistically significant ($p<0.05$) (**Table 7**).

Table 7. Frequency of serologic patterns at patient group according to clinical stage of HPV B19 infection

Age	IgM (-) and IgG (-)		IgM (-)and IgG (+)		IgM (-) and IgG (+)		IgM (-) and IgG (+)	
	n	%	n	%	n	%	n	%
0-5, n=83	42	50.6	31	37.3	6	7.2	4	4.8
6-10, n=44	17	38.6	18	40.9	5	11.3	4	9.1
11-15, n=41	10	24.4	30	73.2	1	2.4	0	0
16+, n=14	1	7.2	10	71.4	3	21.4	0	0
Total, n=182	70	38.4	89	48.9	15	8.2	8	4.4

DISCUSSION

HPV B19 was first described in 1975 by Cossartm et al. (1) discovered during the screening of healthy blood donors sera for hepatitis B surface antigen by immunoelectrophoresis (2,3). HPV B19, a member of the Parvoviridae family, was known as the only member of the family that infected humans before human bocavirus and human parvovirus 4 were identified (4,5). HPV B19 is widespread all over the world and can be transmitted by blood transfusion, organ transplantation, transplacental route and respiratory secretions (6,7). HPV B19 is a small-sized and heat-resistant virus, and many studies in the literature, such

as Pandey et al. (8), Huang et al. (9), have reported that the risk is different for each transmission. HPV B19, which causes arthropathies in adults, especially women, causes erythema infectiosum, which is one of the rash diseases in children (9,10). The virus affects immature erythrocyte serial cells in patients with chronic hemolytic anaemia, stopping erythrocyte production and may cause an aplastic crisis (10). In addition, HPV B19 can cause hydrops fetalis and congenital anaemia in pregnant women (7). In our study, we investigated the prevalence of HPV B19 in a cross-sectional population.

HPV B19 is a very common infection all over the world (11). Genotype 1 and 2 are more common in Europe, the United States and other Western countries, and genotype 3 in Sub-Saharan Africa and South America. Although the infection can be seen at all ages, it is most common in childhood (12,13). It can be seen as an epidemic in the spring months, especially in children attending primary school. Therefore, nursery staff and primary school staff are among the highest risk groups (13). The infection is mainly transmitted by respiratory secretions and close contact is important for contamination (13,14). HPV B19 is a non-enveloped virus and is highly resistant to chemical and physical methods of cleaning. The riskiest material in terms of contamination is coagulation factor concentrates. In addition, transmission is possible through organ transplantation and vertical routes (14,15). Various scenarios have been proposed regarding the risk in transmission. Many authors, such as Germanaud et al. (15), Vafaie et al. (16), Ornoy et al. (17), state that the first factor at risk of transmission is the amount of viral DNA and the second is the immune status of the recipient. In our study, the seroprevalence of HPV PB19 antibodies was investigated in our region, and there are a limited number of studies investigating this issue with evidence of serological infection in our country. In our study, seroconversion against HPV B19 varied between 47.9% and 84.9% in all groups. In the group above 16 years of age, maximum seroconversion (84.9%) was detected

The disease course of HPV B19 is usually biphasic (18). The first stage is in the first week after exposure to the virus, and intense viremia is observed (18,19). At this stage, the virus enters nasal secretions and non-specific symptoms such as fever, headache, malaise, myalgia, and itching are observed. In the course of the disease, loss of reticulocytes in the peripheral smear on the 10th day and a decrease in the number of neutrophils, lymphocytes and platelets along with haemoglobin is observed (19,20). The second stage is the acute phase and starts around the 17th day and progresses with rashes lasting 2 to 3 days. After the rash, symptoms of arthritis are seen, characterized by mild swelling and stiffness in the hand joints, knees and ankles (20). These rash and arthritis findings were seen in HPV B19, where many viral diseases are present, are thought to be immune-mediated. The occurrence of these findings after specific antibodies are formed and the presence of these findings in individuals treated with immunoglobulin support this opinion (20,21). In our study, in the patient group with signs of blood diathesis, acute infection was 19.6% and seroconversion was 55.8%. In the patient group with GIS findings, acute infection was 8.4% and seroconversion was 83.4%. In patients with neurological findings, acute infection was 6.9% and seroconversion was 82.3%. In the group with respiratory system symptoms, acute infection was 22.3% and seroconversion was 58.7%. Our findings were compatible with the literature.

HPV B19 can be produced in freshly taken bone marrow aspiration sample or fetal cord blood, but this method is not routinely preferred because it is not practical (22). Therefore, the diagnosis of HPV B19 infection is based on the detection of virus-specific antibodies by immunological methods or the determination of viral DNA sequences by molecular techniques (22,23). Therefore, Radioimmunoassay (RIA) and Enzyme Immunoassay (EIA) methods that detect HPV B19 IgM and IgG antibodies are widely used in routine practice. IgM-B19 complexes in serum can be detected approximately three days after the onset of viremia symptoms. IgG can be detected in serum approximately one week after IgM (23,24). IgM antibodies gradually disappear after a month. IgG antibodies are found in serum for life. Detection of virus-specific IgM and IgG antibodies in serum generally correlates with the disappearance of the first phase of the disease, namely the disappearance of viremia and improvement of anaemia (24). Some studies have shown the presence of a significant DNA level after 6 months of infection, such as Corcoran et al. (25), Parsyan et al. (26) This is often described as persistent HBV B19 infection and its amount is related to the immune status of the infected person. This condition manifests itself as a lower HBV B19 viral load level in immunocompromised individuals (25,26). In our study, patients with complaints (such as bleeding, GIS findings, rash and neurological findings) and those without complaints in terms of IgM and IgG antibodies were examined separately. IgM positivity was observed at variable rates (2.3% vs 18.4%) in all study groups. IgM seropositivity was detected in the control group, while positivity was detected between 2.4% and 21.4% in the patient group. Of the 0-5 age group patients with IgG positivity, 16 were under 1 year old, 13 had complaints, and 3 were the control group. These people were thought to develop seroconversions due to antibodies from their mothers.

HPV B19 infection, which leaves life-long immunity in children and adults, is usually self-limiting (27). There is

no specific method for the virus in terms of treatment. Symptomatic treatment is applied in patients with immune deficiency, chronic hemolytic anaemia and pregnant women who are not immune. Supportive treatments such as blood transfusion are generally applied in these cases (28,29). Anti-inflammatory drugs may be preferred for arthritis symptoms. If cases with the transient aplastic crisis are not diagnosed and intervened in time, anaemia can deepen and result in death. Intravenous immunoglobulin administration is beneficial in reducing viremia and correcting red cell indices in immunocompromised patients (29,30). Also, Arzouk et al. (29) believe that erythropoietin administration during HPV B19 infection may facilitate viral replication. Although intrauterine blood transfusion can be applied if there is anaemia in the fetus, it is not recommended routinely because of the risks associated with the procedure (30). In our study, all cases were treated symptomatically, and aplastic crisis was not observed in any of our patients.

CONCLUSION

HPV B19 is a DNA virus in the Parvoviridae family. Although HPV B19 infection has a good prognosis, it can sometimes cause serious conditions such as aplastic crisis. Therefore, patients who constitute a high-risk group for the disease should be informed about HPV B19 infection and should be warned about medical intervention.

ETHICAL DECLARATIONS

Ethics Committee Approval: Approval was obtained from the non-invasive ethics committee for our study

Informed Consent: All patients signed the free and informed consent form.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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REFERENCES

1. Cossart YE, Field AM, Cant B, Widdows D. Parvovirus-like particles in human sera. Lancet 1975;1:72-3.
2. Guclu AU, Yilmaz S, Baysallar M, Avcı IY. Prevalence and quantity of parvovirus B19 DNA among blood donors from a regional blood center in Turkey. Transfus Apher Sci. 2020;59:102775.
3. Kumar S, Gupta RM, Sen S, et al.. Seroprevalence of human parvovirus B19 in healthy blood donors. Med J Armed Forces India 2013;69:268-72.
4. Zadsar M, Aghakhani A, Banifazl M, et al.. Seroprevalence, molecular epidemiology and quantitation of parvovirus B19 DNA levels in Iranian blood donors. J Med Virol 2018;90:1318-22.
5. Raturi G, Kaur P, Kaur G. Seroprevalence of human parvovirus B19 amongst North Indian blood donors-do current donor testing guidelines need a relook? Transfus Apher Sci 2018;57:646-50.
6. Attwood LO, Holmes NE, Hui L. Identification and management of congenital parvovirus B19 infection. Prenat Diagn 2020;40:1722-31.
7. Bascietto F, Liberati M, Murgano D, et al.. Outcome of fetuses with congenital parvovirus B19 infection:systematic review and meta-analysis. Ultrasound Obstet Gynecol. 2018;52:569-76.
8. Pandey S. Human parvovirus B19 infection in an immunocompromised host. Clin Case Rep 2020;8:3610-1.
9. Huang TR, Wang CC. Parvovirus B19 infection implicated in a false-positive IgM assay for mumps. Pediatr Neonatol 2020;61:669-70.
10. Russcher A, Enders A, de Brouwer CS, et al.. Diagnosis of intrauterine parvovirus B19 infection at birth - Value of DNA detection in neonatal blood and dried blood spots. J Clin Virol 2020;129:104482.
11. Barlinn R, Trogstad L, Rollag H, et al.. Parvovirus B19 DNAemia in pregnant women in relation to perinatal death:A nested case-control study within a large population-based pregnancy cohort. Acta Obstet Gynecol Scand 2020;99:856-64.
12. Zavattoni M, Paolucci S, Sarasini A, et al.. Diagnostic and prognostic value of molecular and serological investigation of human parvovirus B19 infection during pregnancy. New Microbiol 2016;39:181-5.
13. Broliden K, Tolfvenstam T, Norbeck O. Clinical aspects of parvovirus B19 infection. J Intern Med 2006;260:285-304.
14. Kumano K. Various clinical symptoms in human parvovirus B19 infection. Nihon Rinsho Meneki Gakkai Kaishi 2008;31:448-53.
15. Germanaud D, Sermet-Gaudelus I. Parvovirus B19:importance of diathesis in the clinical expression of a common infection. Rev Prat 2007;57:1049-55.
16. Vafaie J, Schwartz RA. Parvovirus B19 infections. Int J Dermatol 2004;43:747-9.
17. Ornoy A, Ergaz Z. Parvovirus B19 infection during pregnancy and risks to the fetus. Birth Defects Res 2017;109:311-23.
18. Jensen IP, Thorsen P, Jeune B, Moller BR, Vestergaard BF. An epidemic of parvovirus B19 in a population of 3596 pregnant women:a study of sociodemographic and medical risk factors. Br J Obstet Gynaecol 2000;107:637-43.
19. Qian XH, Zhang GC, Jiao XY, et al.. Genetic diversity of human parvovirus B19 VP1 unique region . Zhonghua Er Ke Za Zhi .2003;41:128-30
20. Smith-Whitley K. Zhao H, Hodinka RL, Kwiatkowski J, et al.. Epidemiology of human parvovirus B19 inchildren with sickle cell disease. Blood 2004;103:422-7.
21. Qian X, Zheng Y, Zhang G, Jiao X, Li Z. Relationship between human parvovirus B19 infection and aplastic anemia. Chin Med Sci J 2000;3:172-4.
22. Barash J, Duhnitzki D, Barak Y, Miron S, Hahn T.Tumor necrosis factor (TNF) alpha and its soluble receptor (sTNFR) p75 during acute human parvovirus B19 infection in children. Immunol Lett 2003;88:109-12
23. Schenach H, Lanthaler AJ, Mayersbach P, et al.. Human parvovirus B19 detection in asymptomatic blood donors:association with increased neopterin concentrations. J Infect Dis 2002;186:1494-7.
24. Barash J, Duhnitzki D, Sthoeger D, Bardenstein R, Barak Y. Human parvovirus B19 infection in children:uncommon clinical presentations.Isr Med Assoc J 2002;4:763-5
25. Corcoran A, Doyle S. Advances in the biology, diagnosis and host-pathogen interactions of parvovirus B19. J Med Microbiol 2004;53:459-75.
26. Parsyan A, Candotti D. Human erythrovirus B19 and blood transfusion – an update. Transfus Med 2007;17:263-278

27. Johargy AK, Jamal A, Ashgar SS, Ahmed FR, Kalkatawi MH. Prevalence of human parvovirus B19 in neurological patients:findings from Region of Western Saudi Arabia. Curr Health Sci J 2020;46:16-22.
28. Li X, Lin Z, Liu J, et al.. Overall prevalence of human parvovirus B19 among blood donors in mainland China:A PRISMA-compliant meta-analysis. Medicine (Baltimore) 2020;99:e19832.
29. Arzouk N, Snanoudj R, Beauchamp-Nicoud A, et al.. Parvovirus B19-induced anemia in renal transplantation:a role for rHuEPO in resistance to classical treatment. Transpl Int 2006;19:166-9.
30. Juhl D, Görg S, Hennig H. Persistence of parvovirus B19 (B19V) DNA and humoral immune response in B19V-infected blood donors. Vox Sang 2014; 107:226-32.