

HEPATİT C

Gözde DERVİŞ HAKİM¹

GİRİŞ

1970'li yılların başlarında hepatit A ve hepatit B virüslerinin keşfinden sonra, akut ve kronik hepatit vakalarının büyük bir kısmının bu ajanlardan herhangi biri ile açıklanamayacağı anlaşıldı. 1989 yılında, non-A, non-B hepatitis olarak adlandırılan, kronik ve akut enfeksiyona yol açabilen viral ajan saptandı. Bu virüsün genomunun klonlanması sonucu Hepatit C virüsü (HCV) olarak adlandırıldı (1). Tüm dünyada 200 milyondan fazla insanın HCV ile enfekte olduğu bilinmektedir (2,3). HCV ilişkili mortalite oranları 1995 sonrası dramatik artış gösterirken, 2002 sonrası plato çizmiş ve son yıllarda yeni bulunan tedaviler ile azalma eğilimine geçmiştir (4,5).

VİROLOJİ

HCV, Flaviviridae ailesinde yer alan Hepacivirus genuşu içinde sınıflandırılan, 50 nm çapında sferyik, lipid zarflı, pozitif iplikçikli, tek zincirli bir RNA virüsüdür (6,7). İkozahedral simetrisi olan nükleokapsid, genomik RNA ve birçok kor proteini kopyasından oluşmaktadır. Nükleokapsid; E1 ve E2 zarf glikoproteinlerinin gömülü olduğu, konak hücre kaynaklı çift-katmanlı lipid zarf ile çevrilidir. Kor proteini, E1 ve E2 zarf glikoproteinleri virionun ana protein komponentleridir (8,9).

HCV genomu, yaklaşık 9600 nükleotid içeren pozitif iplikçikli, tek zincirli bir RNA'dır. Genom, yüksek oranda korunmuş kısa bir 5'UTR (untranslated region, translasyon olmayan bölge), uzun bir açık okuma çerçevesi (ORF) ve kısa bir 3'UTR bölgesinden oluşur (7). Genomun 5' UTR bölgesi, 341 nükleotid uzunluğundadır. Bütün HCV suşları arasında benzerlik gösterir. Bu nedenle vireminin saptanmasında hedef bölge haline gelmiştir. 5' UTR bölgesi, viral genomun ökaryotik ribozomun 40S alt ünitesine bağlanarak translasyonunu sağlayan bölgedir. 5' UTR bölgesinde bu bağlanmayı sağlayan kısım "internal ribosomal entry site" (IRES) olarak adlandırılmaktadır ve başlangıçtaki 29 nükleotid hariç, 5' UTR'nin tamamı bu işlevde yer almaktadır. Buna karşılık ilk 23 nükleotidin, translasyonu baskılayıcı rolü olduğu sanılmakta ve bu bölgenin gelecekte antivirallere uygun bir hedef oluşturabileceği düşünülmektedir (10).

3'UTR bölgesi ise, poly-U ya da poly-A ile sonlanan yaklaşık 27 ila 54 nükleotidi içermektedir. Poly-U bölgesinden sonra, çok iyi korunmuş 98 baz uzunluğunda, 3'-X dizisi adı verilen bölge yer alır. Bu bölgenin, virüs replikasyonunda, negatif RNA zincirinin sentezinin başlamasında rol oynadığı düşünülmektedir. Bu bölge "replikaz tanıma bölgesi" olarak tanımlanmaktadır (11).

Tek iplikçikli RNA yaklaşık 3000 aminoasit içeren tek bir poliprotein sentezler.

¹ Doç. Dr. Gözde DERVİŞ HAKİM SBÜ Tepecik Eğitim ve Araştırma Hastanesi, Gastroenteroloji Bölümü, gozdedervis@gmail.com

Yeniden herhangi bir tedavi şemasına dahil edilmeyecek hastalarda ise; 3-6 ayda bir karaciğer hastlığının ilerleyip ilerlemediğini takip amaçlı; biyokimya, hemogram, pihtlaşma zamanı içeren testler yanı sıra, hepatoselüler kanser açısından 6 ayda 1 ultrason ve alfa fetoprotein takibi yapılmalıdır.

Sirozu olan hastalarda Üst Gastrointestinal sistem (gis) endoskopisi ile varis takibi yapılmalıdır.

Tedavi Başarısı Elde Edilen Hastaların Takibi:

Kalıcı viral yanıt elde edilen hastalarda, tekrar HCV enfeksiyon riski yoksa, HCVRNA takibi yapılmasına gerek yoktur. Ancak uyuşturucu kullanımı, intravenöz madde kullanımı, çok eşlilik, riskli cinsel davranışları olanlarda, yeniden bulaş açısından 6 ayda bir HCVRNA düzeyi takibi önerilir.

İleri fibrozisi olan hastalarda, 6 ayda 1 ultrason takibi ile hepatoseluler kanser açısından takibi bırakmamak gerekmektedir.

Siroz hastalarında, üst gis endoskopileri ile varis takibi yapılmalıdır.

Hasta kalıcı viral yanıt gelişikten sonra imunsupresif tedavi alacaksa tekrar HCV alevlenme riskine sahip değildir. Takip gerektirmez (143).

Sonuç

1990'lı yılların başında tanımlanan Hepatit C Virüsü, önceleri oldukça mortal bir virus olarak karşımıza çıkışmasına rağmen günümüzde virüsün yapısının çözümlenmesi ve bunlara karşı geliştirilen direk etkili antivirallerin keşfi ile, tedavide %99' lara varan başarı oranı sayesinde tarih sayfalarından silinmeye yüz tutmuştur. Tedavide başarı oranı bu kadar yüksek olmasına rağmen hala dünya üzerinde hatırlı sayılar oranda tedavi edilmemiş Hepatit C pozitif hastalar bulunmaktadır.

KAYNAKLAR

1. Choo QL, Kuo G, Weiner AJ, et al. Isolation of a cDNA clone derived from a blood-borne non-A, non-B viral hepatitis genome. *Science* 1989; 244:359.).
2. Hanafiah KM, Groeger J, Flaxman AD, et al. Global epidemiology of hepatitis C virus infection: New estimates of age-specific antibody to HCV seroprevalence. *Hepatology* 2013; 57:1333-42.
3. European Association for the Study of the Liver. EASL Clinical Practice Guidelines: Management of hepatitis C virus infection. *J Hepatol* 2011; 55:245-64.
4. Wise M, Bialek S, Finelli L, et al. Changing trends in hepatitis C-related mortality in the United States, 1995-2004. *Hepatology* 2008; 47:1128-35.
5. Razavi H, ElKhoury AC, Elbasha E, et al. Chronic hepatitis C virus (HCV) disease burden and cost in the United States. *Hepatology* 2013; 57:2164-70.
6. Bukh J. The history of hepatitis C virus (HCV): Basic research reveals unique features in phylogeny, evolution and the viral life cycle with new perspectives for epidemic control. *J Hepatol* 2016; S2-21. doi:10.1016/j.jhep.2016.07.035.
7. Akhan S. Hepatit C Virusu. Willke Topçu A, Söyletilir G, Doğanay M (Editörler). *Enfeksiyon Hastalıkları ve Klinik Mikrobiyolojisi*, 3.baskı. İstanbul: Nobel Tip Kitabevleri; 2008. 1911-29.
8. Catane MT, Uryu K, Kopp M, Edwards TJ, Andrus L, Rice WJ, et al. Ultrastructural analysis of hepatitis C virus particles. *Proc Natl Acad Sci U S A* 2013;110:9505-9510.
9. Vieyres G, Dubuisson J, Pietschmann T. Incorporation of hepatitis C virus e1 and e2 glycoproteins: the keystones on a peculiar virion. *Viruses* 2014;6:1149-1187.
10. Wasley A, Alter MJ. Epidemiology of hepatitis C: geographic differences and temporal trends. *Semin. Liver Dis.* 2000;20:1-16.
11. Neumann AU, Lam NP, Dahari H, et al. Hepatitis C viral dynamics in vivo and the antiviral efficacy of interferon-alpha therapy. 1998.
12. Alberti A, Benvegnù L. Management of hepatitis C. *J Hepatol* 2003; 38 (Suppl 1): 104-118.
13. Chevaliez S, Pawlotsky JM. HCV Genome and Life Cycle. In: Tan SL, editor. *Hepatitis C Viruses: Genomes and Molecular Biology*. Norfolk (UK): Horizon Bioscience; 2006 Chapter1 Available from: <https://www.ncbi.nlm.nih.gov/books/NBK1630>.
14. T. Suzuki, R. Suzuki, Maturation and assembly of hepatitis C virus core protein, in: M. Kalitzky, P. Borowski (Eds.), *Molecular Biology of the Flavivirus*, Horizon Bioscience, Norfolk, U.K., 2006, pp. 295-311.
15. L. Frasca, P. Del Porto, L. Tuosto, B. Marinari, C. Scotta, M. Carbonari, A. Nicosia, and E. Piccolella, Hyper-variable region 1 variants act as TCR antagonists for hepatitis C virus-specific CD4+ T cells. *J. Immunol* 1999; 163: 650-658.
16. Kato N, Sekiya H, Ootsuyama Y, et al. Humoral immune response to hypervariable region 1 of the putative envelope glycoprotein (gp70) of hepatitis C virus. *J. Virol.* 1993 Jul; 67(7): 3923-30.
17. Vassilaki N, Mavromara P. The HCV ARFP/F/core+1 protein: production and functional analysis of an unconventional viral product. *IUBMB Life* 2009; 61: 739-752.
18. Park, S. B., Seronello, S., Mayer, W., & Ojcius, D. M. (2016). Hepatitis C Virus Frameshift/Alternate Reading Frame Protein Suppresses Interferon Responses Mediated by Pattern Recognition Receptor Retinoic-Acid-Inducible Gene-I. *PLoS ONE*, 11(7), e0158419.
19. Dalagiorgou G, Vassilaki N., Foka P., Boumlic a., Kakkanas a., Kochlios E., Khalili S., Aslanoglu E., Veletza S., Orfanoudakis G., Vassilopoulos D., Hadziyannis S.

- J., Koskinas J., and Mavromara P., "High levels of HCV core+1 antibodies in HCV patients with hepatocellular carcinoma," *J. Gen. Virol.* 2011; vol. 92, no. 6, pp. 1343–1351.
20. Kato N. Molecular virology of hepatitis C virus. [Review] [358 refs]. *Acta Med. Okayama.* 2001;55:133–159.
 21. Boson B, Granio O, Bartenschlager R, Cosset FL. A concerted action of hepatitis C virus p7 and nonstructural protein 2 regulates core localization at the endoplasmic reticulum and virus assembly. *PLoS Pathog.* 2011;7:e1002144.
 22. Suzuki R, Matsuda M, Watashi K, Aizaki H, Matsuuwa Y, Wakita T, et al. Signal peptidase complex subunit 1 participates in the assembly of hepatitis C virus through an interaction with E2 and NS2. *PLoS Pathog.* 2013;9:e1003589.
 23. Li, K., Foy, E., Ferreon, J. C., Nakamura, M., Ferreon, A. C., Ikeda, M., Ray, S. C., Gale, M. Jr., Lemon, S. M. (2005). Immune evasion by hepatitis C virus NS3/4A protease-mediated cleavage of the Toll-like receptor 3 adaptor protein TRIF. *Proc. Natl Acad. Sci. USA,* 102: 2992 – 2997.
 24. Meylan, E., Curran, J., Hofmann, K., Moradpour, D., Binder, M., Bartenschlager, R., Tschoop, J. (2005). Cardif is an adaptor protein in the RIG-I antiviral pathway and is targeted by hepatitis C virus. *Nature,* 437: 1167 – 1172.
 25. M. Lundin, M. Monne, A. Widell, G. Von Heijne, M.A. Persson, Topology of the membrane-associated hepatitis C virus protein NS4B, *J. Virol.* 77 (9) (2003) 5428–5438.
 26. Ahmed A., Felmlee D. Mechanisms of hepatitis C viral resistance to direct acting antivirals *Viruses,* 2015; 7 (12).
 27. Moradpour D., Penin, F., Rice, C. M. (2007). Replication of hepatitis C virus. *Nat. Rev. Microbiol.*, 5: 453 – 463.
 28. Akinci E, Bodur H. HCV infeksiyonunda klinik ve tanı. In: Tabak F, Bahış İ, Tekeli E (eds). *Viral hepatit 2007.* İstanbul: Viral Hepatit Savaşı Derneği; 2007. 208-19.
 29. Guedj J, Dahari H, Rong L, et al. Modeling shows that the NS5A inhibitor daclatasvir has two modes of action and yields a shorter estimate of the hepatitis C virus half-life. *Proc Natl Acad Sci U S A* 2013; 110:3991-6.
 30. Forn X, Purcell RH, Bukh J. Quasispecies in viral persistence and patogenesis of hepatitis C virus. *Trends in Microbiology* 1999; 7: 402-410.
 31. Doming E. Biological significance of viral quasispecies. *Viral Hepatitis Rev.* 1996; 2: 247-261.
 32. Higashi Y, Kakumu S, Yoshioka K, Wakita T, Mizokami M, Ohba K, et al. Dynamics of genome change in the E2/NS1 region of hepatitis C virus *in vivo.* *Virology* 1993;197:659–68.
 33. Kojima M, Osuga T, Tsuda F, Tanaka T, Okamoto H. Influence of antibodies to the hypervariable region of E2/NS1 glycoprotein on the selective replication of hepatitis c virus in chimpanzees. *Virology* 1994;204:665-72.
 34. Hayashi J, Kishihara Y, Yamaji K, Furusyo N, Yamamoto T, Pae Y, et al. Hepatitis C viral quasispecies and liver damage in patients with chronic hepatitis C virus infection. *Hepatology* 1997;25:697–701.
 35. Aydemir S. Antiviral Direnç. Kandemir Ö., Danaloğlu A. (Editörler). *Hepatit B'den D'ye Hep Güncel - Klinik El Kitabı* içerisinde. İstanbul: Content Ed Net Türkîye.2015, 214-26.
 36. Zein, Nizar N. "Clinical Significance of Hepatitis C Virus Genotypes." *Clinical Microbiology Reviews* 13.2 (2000): 223–235.
 37. Smith DB, Bukh J, Kuiken C, et al. Expanded classification of hepatitis C virus into 7 genotypes and 67 subtypes: updated criteria and genotype assignment web resource. *Hepatology* 2014; 59:318.
 38. Nakano I, Fukuda Y, Katano Y, et al. Interferon responsiveness in patients infected with hepatitis C virus 1b differs depending on viral subtype. *Gut* 2001; 49: 263-267.
 39. Messina JP, Humphreys I, Flaxman A, Brown A, Cooke GS, Pybus OG, Barnes E. Global distribution and prevalence of hepatitis C virus genotypes. *Hepatology.* 2015 Jan;61(1):77-87.
 40. Webster G. HCV genotypes-role in pathogenesis of disease and response to therapy. *Bailliere's Clinical Gastroenterology* 2000; 14: 229-240.45
 41. Murphy DG, Sablon E, Chamberland J, Fournier E, Dandavino R, Tremblay CL. Hepatitis C virus genotype 7, a new genotype originating from central Africa. *J Clin Microbiol.* 2015;53(3):967–972.
 42. Morice Y, Cantaloube JF, Beaucourt S, Barbotte L, De Gendt S, Goncales FL, et al. Molecular epidemiology of hepatitis C virus subtype 3a in injecting drug users. *J Med Virol.* 2006;78:1296-1303.
 43. Uddin G, Shoeb D, Solaiman S, Marley R, Gore C, Ramsay M, et al. Prevalence of chronic viral hepatitis in people of south Asian ethnicity living in England: the prevalence cannot necessarily be predicted from the prevalence in the country of origin. *J Viral Hepat* 2010;17:327-335.
 44. Frank C, Mohamed MK, Strickland GT, Lavanchy D, Arthur RR, Magder LS, et al. The role of parenteral antischistosomal therapy in the spread of hepatitis C virus in Egypt. *Lancet* 2000;355:887-891.
 45. Mistik R. Hepatit C Virüs Enfeksiyonunun Epidemiolojisi. Editörler: Fehmi Tabak, Selma Tosun. *Viral Hepatit 2013, Viral Hepatit Savaşı Derneği Yayıncı. İstanbul Tip Kitabevi 2013, İstanbul, 2013;* 83-112.
 46. Altuglu I, Soyler I, Ozacar T, Erensoy S. Distribution of hepatitis C virus genotypes in patients with chronic hepatitis C infection in Western Turkey. *Int J Infect Dis.* 2008;12(3): 239-44.
 47. World Health Organization. Web Annex B. WHO estimates of the prevalence and incidence of hepatitis C virus infection by WHO region, 2015. In: Global hepatitis report 2017. <https://apps.who.int/iris/bitstream/handle/10665/277005/WHO-CDS-HIV-18.46-eng.pdf> (Accessed on May 21, 2019.).
 48. Polaris Observatory HCV Collaborators. Global prevalence and genotype distribution of hepatitis C virus infection in 2015: a modelling study. *Lancet Gastroenterol Hepatol* 2017; 2:161.
 49. Lo III R V, Kostman JR. Management of chronic hepatitis C. Postgraduate medical journal, {postgr. Med J}, Jun 2005, vol.81., no.956., p.376.82., 81.refs., ISSN. 1469.0756. 2005;81:376.
 50. Bozkurt, İ., et al., Bölgemizdeki hemodiyaliz hastalarında hepatitis C virusu infeksiyonunun sıklığı ve epidemiolojik özellikleri. *Klinik Dergisi,* 2011. 24(3): p. 167-72.

51. Moreira, R.C., et al., Hepatitis C and hemodialysis: a review. *Brazilian Journal of Infectious Diseases*, 2005. 9(4): p. 269-275.
52. Shepard CW, Finelli L, Alter MJ. Global epidemiology of hepatitis C virus infection. *Lancet Infect Dis*. 2005;5:558–567. doi:10.1016/S1473-3099(05)70216-4
53. Sulkowski M, Ray S, Thomas D. Needlestick transmission of hepatitis C. *JAMA* 2002; 287:2406-13.
54. De Carli G, Puro V, Ippolito G. Risk of hepatitis C virus transmission following percutaneous exposure in healthcare workers. *Infection* 2003; 31:22-7.
55. Kubitschke A, Bahr MJ, Aslan N, et al. Induction of hepatitis C virus (HCV)-specific T cells by needle stick injury in the absence of HCV-viraemia. *Eur J Clin Invest* 2007; 37:54-64.
56. Hosoglu S, Celen MK, Akalin S, et al. Transmission of hepatitis C by blood splash into conjunctiva in a nurse. *Am J Infect Control*. 2003;31:502–504.
57. Gibb D, Goodall R, Dunn D, et al. Mother-to-child transmission of hepatitis C virus: Evidence for preventable peripartum transmission. *Lancet* 2000; 356:904-7.
58. Conte D, Fraquelli M, Prati D, et al. Prevalence and clinical course of chronic hepatitis C virus (HCV) infection and rate of HCV vertical transmission in a cohort of 15,250 pregnant women. *Hepatology* 2000; 31:751-5.
59. Ghany MG, Nelson DR, Strader DB, et al. An update on treatment of genotype 1 chronic hepatitis C virus infection: 2011 Practice Guideline by the American Association for the Study of Liver Diseases. *Hepatology* 2011; 54:1433-44.
60. Terrault NA. Sexual activity as a risk factor for hepatitis C. *Hepatology*. 2002;36:S99–S105.
61. Terrault NA, Dodge JL, Murphy EL, et al. Sexual transmission of hepatitis C virus among monogamous heterosexual couples: The HCV partners study. *Hepatology* 2013; 57:881-9.
62. Riestra Menéndez S, Rodríguez García R, Suárez González A, et al. Intrafamilial spread of hepatitis C virus. *Infection*. 1991;19:431–433.
63. Saltoğlu N, Taşova Y, Burgut R, Dündar IH. Sexual and non-sexual intrafamilial spread of hepatitis C virus: Intrafamilial transmission of HCV. *Eur. J. Epidemiol.* 1998;14:225–228.
64. Hepatitis C Guidance 2019 Update: American Association for the Study of Liver Diseases–Infectious Diseases Society of America Recommendations for Testing, Managing, and Treating Hepatitis C Virus Infection. *Hepatology*, VOL . 71, NO. 2, 2020
65. Hwang L, Kramer J, Troisi C, et al. Relationship of cosmetic procedures and drug use to hepatitis C and hepatitis B virus infections in a low-risk population. *Hepatology* 2006; 44:341-51.
66. Frank C, Mohamed M, Strickland G, et al. The role of parenteral antischistosomal therapy in the spread of hepatitis C virus in Egypt. *Lancet* 2000; 355:887-91.
67. Takaki A, Wiese M, Maertens G, et al. Cellular immune responses persist and humoral responses decrease two decades after recovery from a single-source outbreak of hepatitis C. *Nat Med* 2000; 6:578-82.
68. Rehermann B. Pathogenesis of chronic viral hepatitis: Differential roles of T cells and NK cells. *Nat Med* 2013;19:859-68.
69. Dixon L, Crawford J. Early histologic changes in fibro-
sing cholestatic hepatitis C. *Liver Transpl* 2007; 13:219-26.
70. Gane E. The natural history and outcome of liver transplantation in hepatitis C virus-infected recipients. *Liver Transpl* 2003; 9:S28-34.
71. Lim H, Lau G, Davis G, et al. Cholestatic hepatitis leading to hepatic failure in a patient with organ-transmitted hepatitis C virus infection. *Gastroenterology* 1994; 106:248-51.
72. Horner SM, Gale M Jr. Regulation of hepatic innate immunity by hepatitis C virus. *Nat Med* 2013; 19:879-88.
73. Lunemann S, Schlapoff V, Cornberg M, et al. NK cells in hepatitis C: Role in disease susceptibility and therapy. *Dig Dis* 2012; 30(Suppl 1):48-54.
74. Akinci E, Bodur H. HCV infeksiyonunda klinik ve tanı. In: Tabak F, Balık İ, Tekeli E (eds). *Viral hepatit 2007*. İstanbul: Viral Hepatit Savaşı Derneği; 2007. 208-19.
75. Ishii S, Koziel MJ. Immune responses during acute and chronic infection with hepatitis C virus. *Clin Immunol* 2008;128(2):133-47
76. Kanto T, Hayashi N. Immunopathogenesis of hepatitis C virus infection: multifaceted strategies subverting innate and adaptive immunity. *Internal Med* 2006; 183-91.
77. Tang H, Grise H. Cellular and molecular biology of HCV infection and hepatitis. *Clin Sci (Lond)*. 2009 Jun 15;117(2):49-65.
78. Sharma, S.A. & Feld, J.J. Acute Hepatitis C: Management in the Rapidly Evolving World of HCV. *Curr Gastroenterol Rep* (2014) 16: 371. doi:10.1007/s11894-014-0371-7
79. Chen SL, Morgan TR. The Natural History of Hepatitis C Virus (HCV) Infection. *International Journal of Medical Sciences*. 2006;3(2):47-52.
80. Feldman: Sleisenger & Fordtran's Gastrointestinal and Liver Disease, 10th ed. Chapter 80-Hepatitis C 1332-51.
81. Backus LI, Boothroyd DB, Phillips BR, et al. A sustained virologic response reduces risk of all-cause mortality in patients with hepatitis C. *Clin Gastroenterol Hepatol* 2011; 9:509-16 e1.
82. Moriya K, Yotsuyanagi H, Shintani Y, et al. Hepatitis C virus core protein induces hepatic steatosis in transgenic mice. *J Gen Virol* 1997; 78(Pt 7):1527-31
83. Rumi MG, De Filippi F, La Vecchia C, et al. Hepatitis C reactivation in patients with chronic infection with genotypes 1b and 2c: A retrospective cohort study of 206 untreated patients. *Gut* 2005; 54:402-6.
84. Maylin S, Laouenan C, Martinot-Peignoux M, et al. Role of hepatic HCV-RNA level on the severity of chronic hepatitis C and response to antiviral therapy. *J Clin Virol* 2012; 53:43-7.
85. Freedman ND, Everhart JE, Lindsay KL, et al. Coffee intake is associated with lower rates of liver disease progression in chronic hepatitis C. *Hepatology* 2009; 50:1360-9.
86. Mosley JW, Operksalski EA, Tobler LH, et al. Viral and host factors in early hepatitis C virus infection. *Hepatology* 2005; 42:86-92.
87. Deterding K, Wiegand J, Gruner N, et al. The German Hep-Net acute hepatitis C cohort: Impact of viral and host factors on the initial presentation of acute hepatitis

- C virus infection. *Z Gastroenterol* 2009; 47:531-40.
88. Ömerci N. Hepatit C Virüsü. In: Tabak F, Tosun S, Editors. *Viral Hepatit 2013*. İstanbul Tip Kitapevi 2013;319-29.
 89. Maasoumy B, Wedemeyer H. Natural history of acute and chronic hepatitis C. *Best Pract Res Clin Gastroenterol* 2012; 26:401-12.
 90. Takahashi M, Yamada G, Miyamoto R, Doi T. Natural course of chronic hepatitis C. *Am J Gastroenterol*. 1993;88(2):240-5.
 91. Afdhal NH. The naturel history of hepatitis C. *Semin Liver Dis* 2004;24:3-8.
 92. Demir M. *HCV Enfeksiyonu Tanısında Kullanılan Testler*. Kandemir Ö, Danaloğlu A. (Editörler). *Hepatit B'den D'ye Hep Güncel - Klinik El Kitabı içerisinde*. İstanbul: Content Ed Net Türkiye.2015, 151-50
 93. Carreño V, Bartolomé J, Castillo I, Quiroga JA. New perspectives in occult hepatitis C virus infection. *World Journal of Gastroenterology : WJG*. 2012;18(23):2887-2894. doi:10.3748/wjg.v18.i23.2887.
 94. Altındış M, Yoldaş O. Viral hepatitlerin tanısında serolojik ve moleküler testler. In: Tabak F, Tosun S (eds). *Viral Hepatit 2013*. 1. Baskı. İstanbul: İstanbul Tip Kitabevi, 2013:161-80.
 95. Chopra S, Clinical manifestations and natural history of chronic hepatitis C virus infection. In: UpToDate, Di Bisceglie AM (Ed). (Accessed on jan. 2015).
 96. Pozzato G, Mazzaro C, Crovatto M, et al. Low-grade malignant lymphoma, hepatitis C virus infection, and mixed cryoglobulinemia. *Blood*. 1994;84:3047-3053
 97. Ferri C, Sebastiani M, Antonelli A, et al. Current treatment of hepatitis C-associated rheumatic diseases. *Arthritis Res Ther* 2012; 14:215.
 98. Siagris D, Christofidou M, Tsamandas A, Lekkou A, Thomopoulos K, Labropoulou-Karatza C. Cryoglobulinemia and progression of fibrosis in chronic HCV infection: cause or effect? *J Infect*. 2004;49:236-41.
 99. Heckmann JG, Kayser C, Heuss D, Manger B, Blum HE, Neundorfer B. Neurological manifestations of chronic hepatitis C. *J Neurol*. 1999;246:486-91
 100. Johnson RJ, Gretch DR, Yamabe H, Hart J, Bacchi CE, Hartwell P, et al. Membranoproliferative glomerulonephritis associated with hepatitis C virus infection. *N Engl J Med*. 1993; 18;328:465-70.
 101. Peveling-Oberhag J, Arcaini L, Hansmann ML, et al. Hepatitis C-associated B-cell non-Hodgkin lymphomas. Epidemiology, molecular signature and clinical management. *J Hepatol* 2013; 59:169-77.
 102. Romero-Gomez M, Fernandez-Rodriguez C, Andrade R, et al. Effect of sustained virological response to treatment on the incidence of abnormal glucose values in chronic hepatitis C. *J Hepatol* 2008; 48:721-7.
 103. Haddad J, Deny P, Munz-Gotheil C, Ambrosini JC, Trinchet JC, Pateron D, et al. Lymphocytic sialadenitis of Sjogren's syndrome associated with chronic hepatitis C virus liver disease. *Lancet* 1992;339:321-3.
 104. Zignego AL, Craxi A. Extrahepatic manifestations of hepatitis C virus infection. *Clin Liver Dis*. 2008;12:611-36.
 105. Wiegand J, Jackel E, Cornberg M, et al. Long-term follow-up after successful interferon therapy of acute hepatitis C. *Hepatology* 2004; 40:98-107.
 106. Chevaliez S, Pawlotsky JM. How to use virological tools for optimal management of chronic hepatitis C. *Liver Int* 2009; 29 Suppl 1: 9-14
 107. Sagnelli E, Coppola N, Marrocco C, Coviello G, Rossi G, Battaglia M, Sagnelli C, Messina V, Tonziello A, Scostatico C, Filippini P. Diagnosis of HCV related acute hepatitis by serial determination of IgM to HCV: a preliminary observation. *J Biol Regul Homeost Agents* 2003; 17: 207-210.
 108. Li, H.-C., & Lo, S.-Y. (2015). Hepatitis C virus: Virology, diagnosis and treatment. *World Journal of Hepatology*, 7(10), 1377-1389. <http://doi.org/10.4254/wjh.v7.i10.1377>.
 109. Alborino F, Burighel A, Tiller FW, et al. Multicenter evaluation of a fully automated third-generation anti-HCV antibody screening test with excellent sensitivity and specificity. *Med Microbiol Immunol* 2000; 200:77-83.
 110. Chevaliez S, Pawlotsky J-M. Virology of hepatitis C virus infection. *Best Pract.Res. Clin. Gastroenterol*. 2012;26:381-9.
 111. Chevaliez S, Pawlotsky JM. Hepatitis C virus: virology, diagnosis and management of antiviral therapy. *World J Gastroenterol* 2007; 13: 2461-2466.
 112. Smith BD, Morgan RL, Beckett GA, Falck-Ytter Y, Holtzman D, Teo CG, et al. Recommendations for the identification of chronic hepatitis C virus infection among persons born during 1945-1965. *MMWR Recomm Rep*. 2012;61(RR-4):1-32.
 113. Lee SR, Kardos KW, Schiff E, Berne CA, Mounzer K, Banks AT, Tatum HA, Friel TJ, Demicco MP, Lee WM, Eder SE, Monto A, Yearwood GD, Guillon GB, Kurtz LA, Fischl M, Unangst JL, Kriebel L, Feiss G, Roehler M. Evaluation of a new, rapid test for detecting HCV infection, suitable for use with blood or oral fluid. *J Virol Methods* 2011; 172: 27-31.
 114. Chevaliez S, Rodriguez C, Pawlotsky JM. New virologic tools for management of chronic hepatitis B and C. *Gastroenterology* 2012; 142:1303-13 e1.
 115. Cobb B, Pockros PJ, Vilchez RA, et al. HCV RNA viral load assessments in the era of direct-acting antivirals. *Am J Gastroenterol* 2013; 108:471-5.
 116. Laperche S, Le Marrec N, Girault A, et al. Simultaneous detection of hepatitis C virus (HCV) core antigen and anti-HCV antibodies improves the early detection of HCV infection. *J Clin Microbiol*. 2005;43:3877-3883.
 117. Colin C, Lanoir D, Touzet S, Meyaud-Kraemer L, Bailly F, Trepo C. Sensitivity and specificity of third-generation hepatitis C virus antibody detection assays: an analysis of the literature. *J Viral Hepat* 2001; 8: 87-95.
 118. Ghany, M.G., et al., Diagnosis, management, and treatment of hepatitis C: an update. *Hepatology*, 2009. 49(4): p. 1335-1374.
 119. Tekeli E, Balık İ. *Viral Hepatit 2003*. Viral Hepatit Savaşım Derneği: Viral Hepatit 2003: 222-225
 120. Yilmaz G. Kronik hepatitlerde invaziv ve invaziv olmayan testlerin karşılaştırılması. In: Tabak F, Tosun S (eds). *Viral Hepatit 2013*. 1. Baskı. İstanbul: İstanbul Tip Kitabevi, 2013: 199-214.
 121. Kleiner, D.E. The liver biopsy in chronic hepatitis C: a view from the other side of the microscope. in *Seminars in liver disease*. 2005. Published in 2005 by Thieme Me-

- dical Publishers, Inc., 333 Seventh Avenue, New York, NY 10001, USA.
122. Knodell RG, Ishak KG, Black WC, Chen TS, Craig R, Kaplowitz N, et al. Formulation and application of a numerical scoring system for assessing histological activity in asymptomatic chronic active hepatitis. *Hepatology* (Baltimore, Md). 1981 Sep-Oct;1(5):431-5. PubMed PMID: 7308988. Epub 1981/09/01. eng.
123. Ishak K, Baptista A, Bianchi L, Callea F, De Groote J, Gudat F, et al. Histological grading and staging of chronic hepatitis. *Journal of hepatology*. 1995 Jun;22(6):696-9. PubMed PMID: 7560864. Epub 1995/06/01. eng.
124. Bedossa P, Poupon T, The French METAVIR Cooperative Study Group. An algorithm for grading activity in chronic hepatitis C. *Hepatology* 1996;24:289-293
125. Perrault J, McGill D.B, Ott B, Taylor W.F. Liver biopsy:- complications in 1000 patients. *Gastroenterology* 1978; 74: 103-106.
126. Gunneson TJ, Menon K.V, Wiesner R.H et al. Ultrasound assisted percutaneous liver biopsy performed by a physician assistant. *Am J Gastroenterol* 2002; 97: 1472-1475.
127. Crockett SD, Kaltenbach T, Keeffe EB. Do we still need a liver biopsy? Are the serum fibrosis tests ready for prime time? *Clin Liver Dis* 2006; 10: 513-34.
128. Regev A, Nherro M, Jeffers LJ ve ark. Sampling error and intraobserver variation in liver biopsy in patients with chronic HCV infection. *Am J Gastroenterol*. 2002; 97:2614-2618
129. Chou R, Wasson N. Blood tests to diagnose fibrosis or cirrhosis in patients with chronic hepatitis C virus infection: a systematic review. *Ann Intern Med* 2013; 158:807.
130. Halfon P, Bacq Y, De Muret A, et al. Comparison of test performance profile for blood tests of liver fibrosis in chronic hepatitis C. *J Hepatol* 2007; 46:395.
131. Calès P, de Ledinghen V, Halfon P, et al. Evaluating the accuracy and increasing the reliable diagnosis rate of blood tests for liver fibrosis in chronic hepatitis C. *Liver Int* 2008; 28:1352.
132. DC Rockey, Bissell DM. Noninvasive measures of liver fibrosis. *Hepatology* 2006;43:113-20.
133. Poupon T, Bismut IF, Munteanu M, Messous D, Thabut D, Ratziu V et al. Biomarkers as non-invasive assessment of hepatic fibrosis in chronic hepatitis C. *J Gastroenterol Hepatol* 2004;19:236-45.
134. Lin ZH, Xin YN, Dong QJ, et al. Performance of the aspartate aminotransferase-to-platelet ratio index for the staging of hepatitis C-related fibrosis: an updated meta-analysis. *Hepatology* 2011; 53:726.
135. Shaheen AAM, Myers RP. Diagnostic accuracy of the aspartate aminotransferase-to-platelet ratio index for the prediction of hepatitis C related fibrosis: a systemic review. *Hepatology* 2007;46: 912-921
136. Halfon P, Bourliere M, Deydier R, et al. Independent prospective multicenter validation of biochemical markers (fibrotest-actitest) for the prediction of liver fibrosis and activity in patients with chronic hepatitis C: the fibropaca study. *Am J Gastroenterol* 2006; 101:547.
137. Salkic NN, Jovanovic P, Hauser G, Bracic M. FibroTest/ Fibrosure for significant liver fibrosis and cirrhosis in chronic hepatitis B: a meta-analysis. *Am J Gastroenterol* 2014; 109:796.
138. Halfon P, Imbert-Bismut F, Messous D, et al. A prospective assessment of the inter-laboratory variability of biochemical markers of fibrosis (FibroTest) and activity (ActiTest) in patients with chronic liver disease. *Comp Hepatol* 2002; 1:3.
139. Becker L, Salameh W, Sferruzzi A, et al. Validation of hepascore, compared with simple indices of fibrosis, in patients with chronic hepatitis C virus infection in United States. *Clin Gastroenterol Hepatol* 2009; 7:696.
140. Williams AL, Hoofnagle JH. Ratio of aspartate to alanine aminotransferase in chronic hepatitis. Relationship to cirrhosis. *Gastroenterology* 1988;95:734-739
141. Sheth SG, Flamm SL, Gordon FD, ve ark. AST/ALT ratio predicts cirrhosis in patients with chronic hepatitis C virus infection. *Am J Gastroenterol* 1998;93:44-48
142. Vallet-Pichard A, Mallet V, Nalpas B ve ark. FIB-4: an inexpensive and accurate marker of fibrosis in HCV infection. Comparison with liver biopsy and Fibrotest. *Hepatology* 2007;46:32-36
143. Hepatit C Tedavi Klavuzu Güncellemesi Türkiye Karaciğer Araştırma Derneği Ve Viral Hepatit Savaşımlı Derneği, Nisan 2019
144. Te, H.S., G. Randall, and D.M. Jensen, Mechanism of action of ribavirin in the treatment of chronic hepatitis C. *Gastroenterol Hepatol*, 2007. 3(3): p. 218-25.
145. Poupon T, Bedossa P, Opolon P. Natural history of liver fibrosis progression in patients with chronic hepatitis C. The OBSVIRC, METAVIR, CLINIVIR, and DOSVIRC groups. *Lancet*. 1997;349 (9055):825-32.
146. Scheel TK, Rice CM. Understanding the hepatitis C virus life cycle paves the way for highly effective therapies. *Nat Med* 2013; 19:837-49.
147. Swain MG, Lai MY, Schiffman ML, et al. A sustained virologic response is durable in patients with chronic hepatitis C treated with peginterferon alfa-2a and ribavirin. *Gastroenterology* 2010; 139:1593-601.
148. Manns MP, Pockros PJ, Norkrans G, et al. Long-term clearance of hepatitis C virus following interferon-2b or peginterferon-2b, alone or in combination with ribavirin. *Hepat* 2013; 20:524-9.
149. J Viral D'Ambrosio R, Aghemo A, Rumi MG, et al. A morphometric and immunohistochemical study to assess the benefit of a sustained virological response in hepatitis C virus patients with cirrhosis. *Hepatology* 2012; 56:532-43.
150. Vera-Llonch M, Martin M, Aggarwal J, et al. Health-related quality of life in genotype 1 treatment-naïve chronic hepatitis C patients receiving telaprevir combination treatment in the ADVANCE study. *Aliment Pharmacol Ther* 2013; 38:124-33.
151. Poordad F, Dieterich D. Treating hepatitis C: current standard of care and emerging direct-acting antiviral agents. *J Viral Hepat* 2012; 19:449.
152. Pockros PJ. New direct-acting antivirals in the development for hepatitis C virus infection. *Therap Adv Gastroenterol* 2010; 3:191.
153. Kieffer TL, Sarrazin C, Miller JS, et al. Telaprevir and pegylated interferon-alpha-2a inhibit wild-type and resistant genotype 1 hepatitis C virus replication in patients. *Hepatology*. 2007;46(3):631-639.

154. Sarrazin C, Rouzier R, Wagner F, et al. SCH 503034, a novel hepatitis C virus protease inhibitor, plus pegylated interferon alpha-2b for genotype 1 nonresponders. *Gastroenterology*. 2007;132(4):1270-1278.
155. Chui CKS, Dong WWY, Joy JB, et al. Development and Validation of Two Screening Assays for the Hepatitis C Virus NS3 Q80K Polymorphism Associated with Reduced Response to Combination Treatment Regimens Containing Simeprevir.
156. Tellinghuisen TL, Foss KL, Treadaway J. Regulation of hepatitis C virion production via phosphorylation of the NS5A protein. *PLoS Pathog* 2008; 4:e1000032.
157. Kowdley KV, Gordon SC, Reddy KR, et al. Ledipasvir and sofosbuvir for 8 or 12 weeks for chronic HCV without cirrhosis. *N Engl J Med* 2014; 370:1879.
158. Sulkowski MS, Gardiner DF, Rodriguez-Torres M, et al. Daclatasvir plus sofosbuvir for previously treated or untreated chronic HCV infection. *N Engl J Med* 2014; 370:211.
159. Pawlotsky JM. Hepatitis C virus resistance to direct-acting antiviral drugs in interferon-free regimens. *Gastroenterology*. 2016; 151(1): 70-86.
160. Carrion JA, Martinez-Bauer E, Crespo G, et al. Antiviral therapy increases the risk of bacterial infections in HCV-infected cirrhotic patients awaiting liver transplantation: A retrospective study. *J Hepatol* 2009; 50:719-28.
161. Everson GT, Terraull NA, Lok AS, et al. A randomized controlled trial of pretransplant antiviral therapy to prevent recurrence of hepatitis C after liver transplantation. *Hepatology* 2013; 57:1752-62. 230.
162. Lacombe K, Rockstroh J. HIV and viral hepatitis coinfections: advances and challenges. *Gut* 2012; 61:47-58.