



## BÖLÜM 27

### Karaciğer Cerrahisi Sonrasında Nutrisyon Desteği

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#### ÖZET

İlerlemiş karaciğer hastalığı olanlarda beslenme sorunları çok faktörlüdür. Bu nedenle gerek medikal tedavi gerekse cerrahi tedavi sürecinde yetersiz beslenme çok büyük zorluklar teşkil etmektedir. Öte yandan iskemi-reperfüzyon hasarı; hepatik rezeksiyonu ve karaciğer transplantasyonunu içeren cerrahi prosedürler sırasında meydana gelen karaciğer hasarının önemli bir nedenidir ve karaciğer rezeksiyonu sonrası beslenme sürecinin niçin özelleşmesi gerektiğini ortaya koymaktadır. Ayrıca cerrahi sonrası bakteriyel translokasyon ve bağırsak florasının durumu iyileşme üzerine doğrudan etkilidir. Yaşam kalitesini iyileştirmek ve beslenmeye bağlı tıbbi komplikasyonları önlemek için ileri karaciğer hastalığı teşhisi konan hastaların beslenme durumları derhal değerlendirilmeli, gerek cerrahi öncesi gerek cerrahi sonrası uygun diyet verilerek desteklenmelidir. Ayrıca altta yatan karaciğer hastalığıyla ilişkili metabolik hastalıkları olanlarda, beslenme bozukluğu olanlarda veya bağırsak hastalığı olanlarda spesifik gıda takviyeleri ve/veya kısıtlama diyetlerinin yapılması gerekmektedir.

#### Giriş

Abdominal cerrahi geçiren hastalarda, beslenme durumunun önemi klinisyenler tarafından gitikçe daha İyi anlaşılmaktadır. Özellikle karaciğer rezeksiyonu endikasyonu olan hasta alt grubunda bu durum daha da ayrı bir öneme sahiptir.

Hepatik rezeksiyon, hepatoselüler karsinom (HCC), kolanjiokarsinom, safra kesesi karsino-

mu, nadir görülen primer hepatobiliyer maligniteler, kolorektal kanser metastazları dahil olmak üzere çeşitli iyi huylu ve kötü huylu hastalıklar için endikedir.(1)

Karaciğer cerrahisi için, ameliyat öncesi beslenme ve değerlendirme konusundaki literatürün çoğu karaciğer nakli bekleyen sirozlu hastalara odaklanmaktadır. Bu nedenle diğer hasta popülasyonları için yapılacak uygulamalar bu hasta

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malıdır. Diyet 1,2-1,6 g/kg protein içermelidir. Düşük dereceli hepatik ensefalopati (derece I ve II) protein kısıtlaması için bir gösterge olmamalıdır. (89),(90)

### Probiyotikler

Probiyotikler, mevcut bağırsak mikrobiyotasının özelliklerini düzenleyebilen tek veya çoklu mikrop kültürleridir. Probiyotikler, bağırsakta anti-inflamatuar etkileri destekleyebilir. Böylece bakteriyel translokasyonu ve endotoksin oluşumunu önleyebilir. Aynı zamanda bağırsakta patojenik bakterilerin çoğalmasını engelleyen antimikrobiyal ajanların sentezinde yer alır.(91) Probiyotikler, TNF- $\alpha$  gibi sitokinlerin salınımını engelleyerek, IL-10 ve tümör büyüme faktörü  $\beta$  (TGF- $\beta$ ) gibi, anti-inflamatuar sitokinlerin salınımını indükleyerek bağışıklık sistemini düzenleyebilir .

Elimizdeki veriler karaciğer transplantasyonu sonrası enfeksiyonları önlemek, siroz, hepatik ensefalopati ve Child-Pugh sınıfı ile ilişkili dolaşım hastalıklarını iyileştirmek için probiyotik kullanımından kaynaklanan bir çok faydanın olduğunu göstermektedir.(92) Probiyotikler, nötrofil fago-sitik kapasitedeki iyileşme sayesinde, bakteriyel translokasyonu engelleyerek enfeksiyonları önlemektedirler. (31)

### Sonuç

Son yirmi yılda karaciğer cerrahisinde komplikasyonlarda ciddi bir azalma ve rezeksiyon sonrası sağkalımda iyileşme ile sonuçlanan, çok önemli teknik atılımlar gerçekleştirilmiştir. Literatürde karaciğer rezeksiyonları sonrası beslenme ile ilgili çalışmaların çoğu, sirotik hastalardan elde edilen verilere dayalı olsada, ameliyat öncesi beslenme durumunun iyi değerlendirilmesi karaciğer rezeksiyonunun başarısı için kilit noktalardan biridir. Yaşam kalitesini iyileştirmek ve beslenmeye bağlı tıbbi komplikasyonları önlemek için, ileri karaciğer hastalığı teşhisi konan hastaların beslenme durumları derhal değerlendirilmeli, gerek cerrahi öncesi gerek cerrahi sonrası uygun diyet müdahaleleri ile hastalar desteklenmelidir. Ayrıca altta yatan metabolik, beslenme veya bağırsak

hastalığı ile ilişkili karaciğer rahatsızlıkları olanlar için spesifik gıda takviyeleri ve/veya kısıtlama diyetlerinin yapılması gerekmektedir.

### Kaynaklar

1. Reddy SK, Barbas A, Turley RS et al (2011) A standard definition of major hepatectomy: resection of four or more liver segments. HPB 13(7):494–502.https://doi.org/10.1111/j.1477-2574.2011.00330.x
2. Ciuni R, Biondi A, Grosso G (2011) Nutritional aspects in patient undergoing liver resection. Updat Surg 63(4):249–252. https://doi.org/10.1007/s13304-011-0121-4
3. Patek AJ, Post J. Treatment of cirrhosis of the liver by a nutritious diet and supplements rich in vitamin B complex. The Journal of clinical investigation 1941;20(5):481–505.
4. Merli M, Nicolini G, Angeloni S, Riggio O. Malnutrition is a risk factor in cirrhotic patients undergoing surgery. Nutrition. 2002 Nov-Dec;18(11-12):978-86. doi: 10.1016/s0899-9007(02)00984-x. PMID: 12431721.
5. Saïdi S.A., Abdelkafi S., Jbahi S., Van Pelt J., El-Feki A. Temporal changes in hepatic antioxidant enzyme activities after ischemia and reperfusion in a rat liver ischemia model: Effect of dietary fish oil. Hum. Exp. Toxicol. 2015;34:249–259. doi: 10.1177/0960327114531991.
6. Hammad A., Kaido T., Uemoto S. Perioperative nutritional therapy in liver transplantation. Surg. Today. 2015;45:271–283. doi: 10.1007/s00595-014-0842-3
7. Álvarez-Mercado A.I., Bujaldon E., Gracia-Sancho J., Peralta C. The Role of Adipokines in Surgical Procedures Requiring Both Liver Regeneration and Vascular Occlusion. Int. J. Mol. Sci. 2018;19:3395. doi: 10.3390/ijms19113395 )
8. European Association for the Study of the Liver. Electronic address: easloffice@easloffice.eu; European Association for the Study of the Liver. EASL Clinical Practice Guidelines on nutrition in chronic liver disease. J Hepatol. 2019;70(1):172-193. doi:10.1016/j.jhep.2018.06.024
9. BAPEN Malnutrition Universal Screening Tool (MUST). Available at https:// www.bapen.org.uk/ screening-and-must/must/introducing-must (Erişim tarihi: 26 Ağustos 2021)
10. Almasaudi AS, McSorley ST, Dolan RD, Edwards CA, McMillan DC. The relation between Malnutrition Universal Screening Tool (MUST), computed tomography-derived body composition, systemic inflammation, and clinical outcomes in patients undergoing surgery for colorectal cancer. Am J Clin Nutr. 2019 Dec 1;110(6):1327-1334. doi: 10.1093/ajcn/nqz230. PMID: 31529042.
11. Karsegard VL, Ferlay O, Maisonneuve N, Kyle UG, Dupertuis YM, Genton L, Pichard C. Outil de dépistage simplifié de la dénutrition: Malnutrition Universal Screening Tool (MUST) [Simplified malnutrition screening tool: Malnutrition Universal Screening Tool (MUST)]. Rev Med Suisse Romande. 2004 Oct;124(10):601-5. French. PMID: 15573502.
12. Morgan MY, Madden AM, Soulsby CT, Morris RW. Derivation and validation of a new global method for assessing nutritional status in patients with cirrhosis.

- Hepatology 2006;44:823–835.
13. Bakshi N, Singh K. Nutrition assessment and its effect on various clinical variables among patients undergoing liver transplant. *Hepatobiliary Surg Nutr* 2016;5:358–371
  14. Figueiredo FA, Dickson ER, Pasha TM, Porayko MK, Therneau TM, Malinchoc M, DiCecco SR, Francisco-Ziller NM, Kasparova P, Charlton MR. Utility of standard nutritional parameters in detecting body cell mass depletion in patients with end-stage liver disease. *Liver Transpl*. 2000 Sep;6(5):575-81. doi: 10.1053/jlts.2000.9736. PMID: 10980056.
  15. Naveau S, Belda E, Borotto E, Genuist F, Chaput JC. Comparison of clinical judgment and anthropometric parameters for evaluating nutritional status in patients with alcoholic liver disease. *J Hepatol* 1995;23:234–235.
  16. Taniguchi E, Kawaguchi T, Itou M, Oriishi T, Ibi R, Torii M, Yoshida K, Adachi Y, Otsuka M, Uchida Y, Tanaka S, Takakura M, Sata M. Subjective global assessment is not sufficient to screen patients with defective hepatic metabolism. *Nutrition*. 2011 Mar;27(3):282-6. doi: 10.1016/j.nut.2009.10.016. Epub 2010 Apr 14. PMID: 20392602
  17. Shin S, Jun DW, Saeed WK, Koh DH. A narrative review of malnutrition in chronic liver disease. *Ann Transl Med*. 2021 Jan;9(2):172. doi: 10.21037/atm-20-4868. PMID: 33569474; PMCID: PMC7867872.
  18. Kondrup J, Allison SP, Elia M, et al. (2003) ESPEN guidelines for nutrition screening 2002. *Clin Nutr* 22, 415–421.
  19. Zacharias T, Ferreira N. Nutritional risk screening 2002 and ASA score predict mortality after elective liver resection for malignancy. *Arch Med Sci*. 2017 Mar 1;13(2):361-369. doi: 10.5114/aoms.2017.65273. Epub 2017 Feb 15. PMID: 28261289; PMCID: PMC5332458.
  20. Dou L, Wang X, Cao Y, Hu A, Li L. Relationship between Postoperative Recovery and Nutrition Risk Screened by NRS 2002 and Nutrition Support Status in Patients with Gastrointestinal Cancer. *Nutr Cancer*. 2020;72(1):33-40. doi: 10.1080/01635581.2019.1612927. Epub 2019 May 11. PMID: 31079488.
  21. Booi AN, Menendez J, Norton HJ, et al. (2015) Validation of a screening tool to identify undernutrition in ambulatory patients with liver cirrhosis. *Nutr Clin Pract* 30, 683–689.
  22. Sasidharan M, Nistala S, Narendhran RT, Murugesh M, Bhatia SJ, Rathi PM. Nutritional status and prognosis in cirrhotic patients. *Trop Gastroenterol* 2012;33:257–264.
  23. McFarlane M, Hammond C, Roper T, et al. (2018) Comparing assessment tools for detecting undernutrition in patients with liver cirrhosis. *Clin Nutr ESPEN* 23, 156–161.
  24. Wu Y, Zhu Y, Feng Y, Wang R, Yao N, Zhang M, Liu X, Liu H, Shi L, Zhu L, Yang N, Chen H, Liu J, Zhao Y, Yang Y. Royal Free Hospital-Nutritional Prioritizing Tool improves the prediction of malnutrition risk outcomes in liver cirrhosis patients compared with Nutritional Risk Screening 2002. *Br J Nutr*. 2020 Dec 28;124(12):1293-1302. doi: 10.1017/S0007114520002366. Epub 2020 Jun 30. PMID: 32600494; PMCID: PMC7656665.
  25. European Association for the Study of the Liver. EASL Clinical Practice Guidelines on nutrition in chronic liver disease. *J Hepatol*. 2019 Jan;70(1):172-193. doi: 10.1016/j.jhep.2018.06.024. Epub 2018 Aug 23. PMID: 30144956; PMCID: PMC6657019.
  26. Morgan MY, Madden AM, Jennings G, Elia M, Fuller NJ. Two-component models are of limited value for the assessment of body composition in patients with cirrhosis. *Am J Clin Nutr* 2006;84:1151–1162.
  27. Cederholm T, Bosaeus I, Barazzoni R, Bauer J, Van Gossum A, Klek S, et al. Diagnostic criteria for malnutrition – An ESPenteral nutrition Consensus Statement. *Clin Nutr* 2015;34:335–340.
  28. Windsor JA, Hill GL. Weight loss with physiologic impairment: a basic indicator of surgical risk. *Ann Surg* 1988; 207: 290–291.
  29. Dumlu, E, Bozkurt, B, Tokaç, M, Kıyak, G, Özkardeş, A, Yalçın, S, Kılıç, M. (2013). Cerrahi Hastalarda Malnütrisyon ve Beslenme Desteği. *Ankara Medical Journal*, 13 (1), 33-39. Retrieved from <https://dergipark.org.tr/en/pub/amj/issue/1745/21488>.
  30. Peralta C, Jiménez-Castro MB, Gracia-Sancho J. Hepatic ischemia and reperfusion injury: effects on the liver sinusoidal milieu. *J Hepatol*. 2013 Nov;59(5):1094-106. doi: 10.1016/j.jhep.2013.06.017. Epub 2013 Jun 25. PMID: 23811302.
  31. Cornide-Petronio ME, Álvarez-Mercado AI, Jiménez-Castro MB, Peralta C. Current Knowledge about the Effect of Nutritional Status, Supplemented Nutrition Diet, and Gut Microbiota on Hepatic Ischemia-Reperfusion and Regeneration in Liver Surgery. *Nutrients*. 2020 Jan 21;12(2):284. doi: 10.3390/nu12020284.
  32. Micó-Carnero M, Rojano-Alfonso C, Álvarez-Mercado AI, Gracia-Sancho J, Casillas-Ramírez A, Peralta C. Effects of Gut Metabolites and Microbiota in Healthy and Marginal Livers Submitted to Surgery. *Int J Mol Sci*. 2020;22(1):44. Published 2020 Dec 22. doi:10.3390/ijms22010044.
  33. Albillos A, de Gottardi A, Rescigno M. The gut-liver axis in liver disease: Pathophysiological basis for therapy. *J Hepatol*. 2020 Mar;72(3):558-577. doi: 10.1016/j.jhep.2019.10.003. Epub 2019 Oct 14. PMID: 31622696.
  34. Cheung K, Lee S, Raman M (2012) Prevalence and mechanisms of malnutrition in patients with advanced liver disease, and nutrition management strategies. *Clin Gastroenterol Hepatol* 10(2): 117–125. <https://doi.org/10.1016/j.cgh.2011.08.016>.
  35. Alberino F, Gatta A, Amodio P, et al. (2001) Nutrition and survival in patients with liver cirrhosis. *Nutrition* 17, 445–450.
  36. O'Brien A, Williams R (2008) Nutrition in end-stage liver disease: principles and practice. *Gastroenterology* 134:1729–1740. <https://doi.org/10.1053/j.gastro.2008.02.001>
  37. Tsiaousi ET, Hatzitolios A, Trygonis SK et al (2008) Malnutrition in end stage liver disease: recommendations and nutritional support. *J Gastroenterol Hepatol* 23(4):527–533. <https://doi.org/10.1111/j.1440-1746.2008.05369.x>
  38. Plauth M, Schütz E (2002) Cachexia in liver cirrhosis. *Int J Cardiol* 85(1):83–87. [https://doi.org/10.1016/S0167-5273\(02\)00236-X](https://doi.org/10.1016/S0167-5273(02)00236-X).
  39. Marchesini G, Bianchi G, Amodio et al (2001) Factors associated with poor health-related quality of life of patients with cirrhosis. *Gastroenterology* 120(1):170–178. <https://doi.org/10.1053/gast.2001.21193>.
  40. Owen OE, Trapp V, Reichard GA Jr et al (1983) Nature

- and quantity of fuels consumed in patients with alcoholic cirrhosis. *J Clin Invest* 72(5):1821–1832. <https://doi.org/10.1172/JCI111142>.
41. Merli M, Leonetti F, Riggio O et al (1999) Glucose intolerance and insulin resistance in cirrhosis are normalized after liver transplantation. *Hepatology* 30(3):649–654. <https://doi.org/10.1002/hep.510300306>.
  42. Mardini HA, Douglass A, Record C (2006) Amino acid challenge in patients with cirrhosis and control subjects: ammonia, plasma amino acid, and EEG changes. *Metab Brain Dis* 21(1):1–10. <https://doi.org/10.1007/s11011-006-9006-5>.
  43. Moscateillo SM, Marchesini G (2007) Diabetes and liver disease: an ominous association. *Nutr Metab Cardiovasc Dis* 17(1):63–70. <https://doi.org/10.1016/j.numecd.2006.08.004>.
  44. Bozzetti F (2002) Rationale and indications for preoperative feeding of malnourished surgical cancer patients. *Nutrition* 18(11/12): 953–959. [https://doi.org/10.1016/S0899-9007\(02\)00988-7](https://doi.org/10.1016/S0899-9007(02)00988-7).
  45. Sungurtekin H, Sungurtekin U, Balci C, Zencir M, Erdem E (2004) The influence of nutritional status on complications after major intraabdominal surgery. *J Am Coll Nutr* 23(3):227–232. <https://doi.org/10.1080/07315724.2004.10719365>.
  46. Weinmann A, Braga M, Carli F, Higashiguchi T et al (2017) ESPEN guideline: clinical nutrition in surgery. *Clin Nutr* 36(3): 623–650. <https://doi.org/10.1016/j.clnu.2017.02.013>.
  47. Gianotti L, Braga M, Nespoli L et al (2002) A randomized controlled trial of preoperative oral supplementation with a specialized diet in patients with gastrointestinal cancer. *Gastroenterology* 122(7):1763–1770. <https://doi.org/10.1053/gast.2002.33587>.
  48. Evans DC, Martindale R, Kiraly LN, Jones CM (2013) Nutrition optimization prior to surgery. *Nutr Clin Pract* 29(1):10–21. <https://doi.org/10.1177/0884533613517006>.
  49. Toh SY, Zarshenas N, Jorgensen J (2009) Prevalence of nutrient deficiencies in bariatric patients. *Nutrition* 25(11-12):1150–1156. <https://doi.org/10.1016/j.nut.2009.03.012>.
  50. Kerns JC, Arundel C, Chawla LS (2015) Thiamin deficiency in people with obesity. *Adv Nutr* 6(2):147–153. <https://doi.org/10.3945/an.114.007526>.
  51. Batsis JA, Mackenzie T, Lopez-Jimenez F, Bartels SJ (2014) Sarcopenia, sarcopenic obesity and mortality in older adults: results from the National Health and Nutrition Examination Survey III. *Eur J Clin Nutr* 68(9):1001–1007. <https://doi.org/10.1038/ejcn.2014.117>.
  52. Tsai S (2012) Importance of lean body mass in the oncologic patient. *Nutr Clin Pract* 27(5):593–598. <https://doi.org/10.1177/0884533612457949>.
  53. Plauth M, Bernal W, Dasarathy S, Merli M, Plank LD, Schütz T, Bischoff SC. ESPEN guideline on clinical nutrition in liver disease. *Clin Nutr*. 2019 Apr;38(2):485–521. doi: 10.1016/j.clnu.2018.12.022. Epub 2019 Jan 16. PMID: 30712783; PMCID: PMC6686849.
  54. Bilbao I, Armadans L, Lazaro JL, Hidalgo E, Castells L, Margarit C. Predictive factors for early mortality following liver transplantation. *Clin Transplant* 2003;17(5):401–11.
  55. Hanai T, Shiraki M, Nishimura K, Ohnishi S, Imai K, Suetsugu A, et al. Sarcopenia impairs prognosis of patients with liver cirrhosis. *Nutrition* 2015;31(1):193–9.
  56. Plank LD, McCall JL, Gane EJ, Rafique M, Gillanders LK, McIlroy K, et al. Pre- and postoperative immunonutrition in patients undergoing liver transplantation: a pilot study of safety and efficacy. *Clin Nutr* 2005;24(2):288–96.
  57. Plank LD, Gane EJ, Peng S, Muthu C, Mathur S, Gillanders L, et al. Nocturnal nutritional supplementation improves total body protein status of patients with liver cirrhosis: a randomized 12-month trial. *Hepatology* 2008;48(2):557–66.
  58. Owen OE, Reichle F, Mozzoli MA et al (1981) Hepatic, gut, and renal substrate flux rates in patients with hepatic cirrhosis. *J Clin Invest* 68(1):240–252. <https://doi.org/10.1172/JCI110240>.
  59. Schütte K, Schuls C, Malfertheiner P (2015) Nutrition and hepatocellular cancer. *Gastrointest Tumors* 2(4):188–194. <https://doi.org/10.1159/000441822>.
  60. Matos C, Porayko M, Francisco-Ziller N (2002) Nutrition and chronic liver disease. *J Clin Gastroenterol* 35(5):391–397. <https://doi.org/10.1097/00004836-200211000-00007>.
  61. Cabré E., Periago J.L., Abad-Lacruz A., González-Huix F., González J., Esteve-Comas M., Fernández-Bañares F., Planas R., Gil A., Sánchez-Medina F., et al. Plasma fatty acid profile in advanced cirrhosis: Unsaturation deficit of lipid fractions. *Am. J. Gastroenterol.* 1990;85:1597–1604. doi: 10.1016/0168-8278(90)91651-C.
  62. Hasse J.M., Blue L.S., Liepa G.U., Goldstein R.M., Jennings L.W., Mor E., Husberg B.S., Levy M.F., Gonwa T.A., Klintmalm G.B. Early enteral nutrition support in patients undergoing liver transplantation. *JPEN J. Parenter. Enteral Nutr.* 1995;19:437–443. doi: 10.1177/0148607195019006437.
  63. Fan S.T., Lo C.M., Lai E.C., Chu K.M., Liu C.L., Wong J. Perioperative nutritional support in patients undergoing hepatectomy for hepatocellular carcinoma. *N. Engl. J. Med.* 1994;331:1547–1552. doi: 10.1056/NEJM199412083312303.
  64. Coolsen MM, Wong-Lun-Hing EM, van Dam RM, van der Wilt AA, Slim K, Lassen K, et al. A systematic review of outcomes in patients undergoing liver surgery in an enhanced recovery after surgery pathways. *HPB (Oxford)* 2013;15(4):245–51 ( Hughes MJ, McNally S, Wigmore SJ. Enhanced recovery following liver surgery: a systematic review and meta-analysis. *HPB (Oxford)* 2014;16(8):699–706.
  65. Gustafsson UO, Scott MJ, Hubner M, Nygren J, Demartines N, Francis N ve ark.(2019). Guidelines for perioperative care in elective colorectal surgery: enhanced recovery after surgery (ERAS) society recommendations: 2018. *World Journal of Surgery*, 43 (3), 659– 695.
  66. Ersoy E, Gündoğdu H (2008). Cerrahi sonrası iyileşmenin hızlandırılması. *Ulusal Cerrahi Dergisi*, 24 (2), 100–103.
  67. Ljungqvist O (2014). ERAS-enhanced recovery after surgery: moving evidence-based perioperative care to practice. *Journal of Parenteral and Enteral Nutrition*, 38 (5), 559– 566.
  68. Gündoğdu RH (2016). Cerrahi İyileşmenin Hızlandırılması İçin Modern Teknikler. Eti Aslan F.(ed.). *Cerrahi Bakım: Vaka Analizleri ile Birlikte*. Ankara: Akademis-

- yen Tıp Kitabevi. S:455-470.
69. Dağıştanlı S, Uygur Kalaycı M, Kara Y (2019). Evaluation of eras protocol in general surgery. *İstanbul Kanuni Sultan Süleyman Tıp Dergisi*, 10 (ek sayı), 9–20.) Topçu ve Öztekin (2016).
  70. Silva R.M., Malafaia O., Torres O.J., Czezczo N.G., Marinho Junior C.H., Kozłowski R.K. Evaluation of liver regeneration diet supplemented with omega-3 fatty acids: Experimental study in rats. *Rev. Col. Bras. Cir.* 2015;42:393–397. doi: 10.1590/0100-69912015006008.
  71. Álvarez-Mercado A.I., Bujaldon E., Gracia-Sancho J., Peralta C. The Role of Adipokines in Surgical Procedures Requiring Both Liver Regeneration and Vascular Occlusion. *Int. J. Mol. Sci.* 2018;19:3395. doi: 10.3390/ijms19113395.
  72. Vasco M., Paolillo R., Schiano C., Sommese L., Cuomo O., Napoli C. Compromised nutritional status in patients with end-stage liver disease: Role of gut microbiota. *Hepatobiliary Pancreat. Dis. Int.* 2018;17:290–300. doi: 10.1016/j.hbpd.2018.06.004.
  73. Yang H.J., Tang L.M., Zhou X.J., Qian J., Zhu J., Lu L., Wang X.H. Ankaflavin ameliorates steatotic liver ischemia-reperfusion injury in mice. *Hepatobiliary Pancreat. Dis. Int.* 2015;14:619–625. doi: 10.1016/S1499-3872(15)60361-7.
  74. Yücel A., Aydoğan M.S., Ucar M., Sarıcı K.B., Karaaslan M.G. Effects of Apocynin on Liver Ischemia-Reperfusion Injury in Rats. *Transplant Proc.* 2019;51:1180–1183. doi: 10.1016/j.transproceed.2019.01.108.
  75. Kim H., Hong M.K., Choi H., Moon H.S., Lee H.J. Chemopreventive effects of korean red ginseng extract on rat hepatocarcinogenesis. *J. Cancer.* 2015;6:1–8. doi: 10.7150/jca.10353.
  76. Müller M.J. Malnutrition in cirrhosis. *J. Hepatol.* 1995;23(Suppl. S1):31–35.
  77. Riggio O., Ariosto F., Merli M., Caschera M., Zullo A., Balducci G., Ziparo V., Pedretti G., Fiaccadori F., Bottari E., et al. Short-term oral zinc supplementation does not improve chronic hepatic encephalopathy. Results of a double-blind crossover trial. *Dig. Dis. Sci.* 1991;36:1204–1208. doi: 10.1007/BF01307509.
  78. Miyauchi T., Uchida Y., Kadono K., Hirao H., Kawasoe J., Watanabe T., Ueda S., Jobara K., Kaido T., Okajima H., et al. Preventive Effect of Antioxidative Nutrient-Rich Enteral Diet Against Liver Ischemia and Reperfusion Injury. *JPEN J. Parenter. Enteral Nutr.* 2019;43:133–144. doi: 10.1002/jpen.1308.
  79. Reynolds P.S., Fisher B.J., McCarter J., Sweeney C., Martin E.J., Middleton P., Ellenberg M., Fowler E., Brophy D.F., Fowler A.A., 3rd, et al. Interventional vitamin C: A strategy for attenuation of coagulopathy and inflammation in a swine multiple injuries model. *J. Trauma Acute Care Surg.* 2018;85:S57–S67. doi: 10.1097/TA.0000000000001844.
  80. Gemperlein K., Dietrich D., Kohlstedt M., Zipf G., Bernauer H.S., Wittmann C., Wenzel S.C., Müller R. Polyunsaturated fatty acid production by *Yarrowia lipolytica* employing designed myxobacterial PUFA synthases. *Nat. Commun.* 2019;10:4055. doi: 10.1038/s41467-019-12025-8.
  81. Barbul A., Fishel R.S., Shimazu S., Wasserkrug H.L., Yoshimura N.N., Tao R.C., Efron G. Intravenous hyperalimentation with high arginine levels improves wound healing and immune function. *J. Surg. Res.* 1985;38:328–334. doi: 10.1016/0022-4804(85)90045-9.
  82. Montenegro W.S., Malafaia O., Nassif P.A., Moreira L.B., Prestes M.A., Kume M.H., Jurkonis L.B., Cella I.F. Evaluation of liver regeneration with use of diet supplemented with L-arginine. *Acta Cir. Bras.* 2014;29:603–607. doi: 10.1590/S0102-8650201400150008.
  83. Magalhães C.R., Malafaia O., Torres O.J., Moreira L.B., Tefil S.C., Pinheiro Mda R., Harada B.A. Liver regeneration with l-glutamine supplemented diet: Experimental study in rats. *Rev. Col. Bras. Cir.* 2014;41:117–121. doi: 10.1590/S0100-69912014000200008.
  84. Akbari M., Celik S.U., Kocaay A.F., Cetinkaya O.A., Demirem S. Omega-3 fatty acid supplementation does not influence liver regeneration in rats after partial hepatectomy. *Clin. Exp. Hepatol.* 2018;4:253–259. doi: 10.5114/ceh.2018.80127.
  85. Kamo N., Kaido T., Hamaguchi Y., Uozumi R., Okumura S., Kobayashi A., Shirai H., Yagi S., Okajima H., Uemoto S. Impact of Enteral Nutrition with an Immunomodulating Diet Enriched with Hydrolyzed Whey Peptide on Infection After Liver Transplantation. *World J. Surg.* 2018;42:3715–3725. doi: 10.1007/s00268-018-4680-0.
  86. Nanno Y., Toyama H., Terai S., Mizumoto T., Tanaka M., Kido M., Ajiki T., Fukumoto T. Preoperative Oral Branched-Chain Amino Acid Supplementation Suppresses Intraoperative and Postoperative Blood Lactate Levels in Patients Undergoing Major Hepatectomy. *JPEN J. Parenter. Enteral Nutr.* 2019;43:220–225. doi: 10.1002/jpen.1445.
  87. Beppu T., Nitta H., Hayashi H., Imai K., Okabe H., Nakagawa S., Hashimoto D., Chikamoto A., Ishiko T., Yoshida M., et al. Effect of branched-chain amino acid supplementation on functional liver regeneration in patients undergoing portal vein embolization and sequential hepatectomy: A randomized controlled trial. *J. Gastroenterol.* 2015;50:1197–1205. doi: 10.1007/s00535-015-1067-y.
  88. Nishikawa H, Osaki Y, Inuzuka T et al (2012) Branched-chain amino acid treatment before transcatheter arterial chemoembolization for hepatocellular carcinoma. *World J Gastroenterol* 18(12):1379–1384. <https://doi.org/10.3748/wjg.v18.i12.1379>.
  89. Kondrup J (2006) Nutrition in end stage liver disease. *Best Pract Res Clin Gastroenterol* 20(3):547–560. <https://doi.org/10.1016/j.bpg.2006.02.001>.
  90. Plauth M, Cabré E, Riggio O et al (2006) ESPEN guidelines on enteral nutrition: liver disease. *Clin Nutr* 25(2):285–294. <https://doi.org/10.1016/j.clnu.2006.01.018>.
  91. Jones S.E., Versalovic J. Probiotic *Lactobacillus reuteri* biofilms produce antimicrobial and anti-inflammatory factors. *BMC Microbiol.* 2009;9:35. doi: 10.1186/1471-2180-9-35.
  92. Sheth A.A., Garcia-Tsao G. Probiotics and liver disease. *J. Clin. Gastroenterol.* 2008;42(Suppl. S2):S80–S84. doi: 10.1097/MCG.0b013e318169c44e.