



Individualized multidisciplinary treatment options for hepatocellular carcinoma in the department of liver surgery: experiences in Xiangya Hospital of Central South University

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Abstract: Hepatocellular carcinoma (HCC) is a highly heterogeneous disease. Genomic and morphological heterogeneity has been well identified in HCC. The overall survival (OS) of HCC patients after hepatic resection (HR) is heterogeneous. The histology-based definition of the morphological heterogeneity of HCC has been modified and refined to treat patients with targeted therapies, but this still cannot solve all the problems. In addition, recent advances in genomic medicine have enhanced the understanding of genetic and epigenetic events occurring in HCC, raising the possibility of personalizing targeted agents in accordance with the genetic make-up of the tumors. In this review article, we aim to give a summary of the recent the development of individualized multidisciplinary treatment for HCC.

Keywords: Hepatocellular carcinoma (HCC); tumor heterogeneous; multidisciplinary treatment

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Introduction

Hepatocellular carcinoma (HCC) is one of the most common malignancies and also the second most frequent cause of cancer-related death worldwide. Each year more than 50% of new HCC cases and deaths occur in China (466,000 and 422,000, respectively) (1,2). To date, a variety of treatments including surgical resection, radiofrequency ablation, transcatheter arterial chemoembolization (TACE), molecular targeted therapy (sorafenib), and radiotherapy have been developed for HCC. Nevertheless, surgical resection remains the treatment of choice for HCC (3,4). Unfortunately, the overall survival (OS) rate of HCC patients has not been substantially improved over the past two decades (5), which may be mainly explained by the fact that HCC is an extremely invasive and metastatic cancer. Thus, prevention of metastasis and recurrence has become a key strategy in improving the postoperative OS of HCC. How to improve the efficacy of

HCC treatment is a common challenge for all countries across the world. HCC is a heterogeneous tumor, with its etiologies being remarkably different globally (for instance, it is mainly caused by hepatitis C virus infection and alcoholic liver disease in Western countries), which may lead to even more complicated prognosis and treatment options (5,6). Currently, multidisciplinary team (MDT) for tumors has become a popular mode for the clinical treatment of tumors both as home and abroad, and the establishment of MDT may help to achieve the optimal individualized treatment of HCC.

MDT establishes individualized treatment protocol for HCC patients

An MDT typically is a group of professionals from two or more disciplines (usually more than two) to provide diagnosis and treatment advices on the disease of a specific

organ or on a systemic disease via regular meetings. Based on the experiences in MDT establishment and combined therapies in China and abroad (especially, surgery is the optimal treatment for HCC (7-10), we established an MDT in the Department of Liver Cancer Surgery: with a surgeon as the leader, professionals from different departments including departments of tumor chemotherapy, radiotherapy, interventional radiology, sonography, radiology, pathology, and infectious diseases are invited to provide the optimal treatment protocol for patients with advanced HCC via case discussions and regular meetings, followed by the implementation of the protocol by all the relevant departments separately or jointly. The MDT members gather on a quarterly basis to discuss and analyze the collected complex cases to form preliminary recommendations for diagnosis and treatment; then, the primary care physician will be responsible for contact the relevant departments to coordinate and arrange the subsequent treatment for the patients. In addition, the MDT members are arranged to attend seminars and workshops in relevant departments quarterly to learn the cutting-edge technologies and recent advances in therapeutic methods. The in-depth exchanges and close cooperation among multiple disciplines have enabled a full integration of HCC diagnosis and treatment theories, technologies, and experiences. Based on the currently available technologies and treatments, the MDT can provide individualized treatment for each patient, thus ensuring each HCC patient can get the optimal individualized diagnosis and treatment protocol and high-quality medical services.

Introduction of the concept of precise hepatectomy

Along with the advances in liver surgical techniques, the obstacles in HCC resection have been broken down one by one, and various hepatic segmentectomy can be smoothly performed. At present, with the developments in the liver surgery techniques, there is no more “forbidden zone” for traditional surgery and laparoscopic liver resection. Surgery-based multidisciplinary treatment remains the mainstream treatment for HCC (11). Anatomical resection is particularly important for liver tumors. Precision hepatectomy is the ultimate goal of liver surgery. Evaluation of liver reserve function combined with computer-aided comprehensive measurement of liver volume can provide reliable information for determining the safe and permissible limits of hepatectomy (12). Before a liver surgery, assessment for

tolerance should be performed firstly, along with assessment of hepatic reserve function (ICG clearance test). By using the three-dimensional (3D) imaging technology, the doctors should have a thorough understanding of the anatomical variations of liver; meanwhile, the residual liver volume and the resected normal liver volume should be calculated by using the 3D simulation module of this software, so as to evaluate the safety of surgical resection. Finally, an appropriate surgical plan is developed (13). During the operation, the satellite lesions in liver parenchyma can be detected by ultrasound, and any injury to the major hepatic duct structures should be avoided. After the measurements, anatomical hepatectomy should be performed with an adequate distance from the outermost edge of the tumor to achieve radical resection. In addition, after localization of the lesion with intraoperative ultrasound, regional vascular occlusion at hepatic hila can reduce the time of normal hepatic ischemia during surgery and control intraoperative bleeding; thus, it can maximize the preservation of liver function and promote postoperative recovery.

Comprehensive application of hepatectomy and its role in rapid rehabilitation following liver resection

According to the concept of modern precision surgery, a liver resection not only requires satisfactory effectiveness but also needs to control intraoperative bleeding and ensure the stabilization of liver function during and after operation. Thus, a right hepatic portal occlusion procedure should be selected for each operation. For hemi-hepatectomy, the first and the second hepatic hilum should be selected, if possible for selective hepatic vascular occlusion. The third hepatic hilum can also be dissected to reduce intraoperative hepatic venous bleeding. Some short hepatic veins can be ligated. Or, prophylactic banding of the superior and inferior vena cava may be performed. Alternatively, by using the liver hanging maneuver, the doctor can lift the liver before or near the inferior vena cava, so as to reduce hepatic vein hemorrhage. Compared with the Pringle maneuver, selective hepatic vascular occlusion can remarkably alleviate the hepatic ischemia-reperfusion injury and thus is particularly valuable for patients with liver dysfunction and small residual functional liver volume after liver resection (9). During hepatic lobectomy or hepatectomy, hepatic inflow occlusion following the dissection of Glissonean pedicle can be performed under the guidance of intraoperative ultrasound. By doing so, we

can both effectively control the intraoperative bleeding and ensure the perfusion of healthy liver, thus maximizing the preservation of liver function. Resection approaches include clamping and snip-electrocoagulation, in combination with high-intensity focused ultrasound (HIFU), bipolar electrocoagulation, and cavitation ultrasonic surgical aspiration (CUSA). After the surgery, the patients should be monitored regularly to assess for liver function and general condition, so as to determine the postoperative recovery. Timely and appropriate postoperative treatment can decrease perioperative mortality, reduce postoperative complications, promote rapid recovery of patients, and shorten hospital stay. Early withdrawal of drainage tube, nasal catheter, and urinary catheter can help the patients to get out of bed as soon as possible, reduce the risk of deep vein thrombosis of lower limbs, promote the recovery of gastrointestinal function, and thus allow rapid resumption of oral feeding. Appropriate postoperative analgesia can reduce the pain during recovery and thus promote adequate rest and maintain sufficient energy. In summary, the integration of precision liver surgery with perioperative Enhanced Recovery After Surgery (ERAS) can both ensure the effectiveness of surgical treatment of liver cancer and promote the rapid and safe recovery after operation. Thus, attention must be paid to its role in liver resection.

Surgical treatment of HCC with portal vein tumor thrombus (PVTT)

PVTT is a common lesion associated with advanced HCC. Patients with HCC with PVTT often have various unfavorable features such as early intrahepatic dissemination of tumors, early treatment failure, and deterioration of liver function, and the treatment outcomes are often far from satisfactory (14). Some authors have classified PVTT into three types: type A (tumor thrombi involving the main portal vein trunk); type B (tumor thrombi involving right/left portal vein); and type C (tumor thrombi involving segmental branches of portal vein or above). After the combined treatment with HR and TACE, the OS of patients with type B/C PVTT was 57%, which was significantly higher than that (13%) of TACE alone group. In patients with type A PVTT, however, the response rate showed no significant difference between the combination group and TACE alone group (8). In a previous study, HCC with PVTT was regarded as a surgical contraindication, and only conservative treatment was given; however, the efficacy of systemic chemotherapy was

poor, with an average survival time of only 3.9 months; furthermore, regional chemotherapy also only yielded an average survival time of 9.2 months (15). For HCC patients with PVTT, hepatic resection (HR) is the only possible way to completely remove the tumor from the liver parenchyma and portal vein, and can reduce the burden of the tumor and the risk of intrahepatic metastases; also, it can lower portal vein pressure, reduce complications caused by portal hypertension, and improve liver function; finally, after the tumor is removed, it provides opportunities and conditions for further multidisciplinary treatment (16). With the development of surgical techniques, the safety of surgical operations has constantly being improved, and the superiority of surgical treatment over conservative treatment has increasingly been recognized. However, the effectiveness of surgical treatment alone in treating HCC with PVTT is not satisfactory. Although PVTT is no longer a surgical contraindication and it is safe and feasible to perform HR, there is no significant improvement in the outcomes. Thus, the surgical treatment should be carefully selected and tailored. The advances in MDT treatment and precision medicine will further improve the holistic treatment of HCC.

Highly selective application of two-stage hepatectomy

Based on the deeper understanding of liver anatomy, Schmitt firstly reported the associating liver partition and portal vein ligation for staged hepatectomy (ALPPS) (17). ALPPS is based on the following principle: the regeneration of the liver requires the portal vein blood flow that is rich in liver regeneration factors; selective transection of the portal vein at one side can adjust/change hepatic inflow and promote the regeneration of future liver remnant (FLR). Thus, some HCC patients who were traditionally regarded as inoperable now have a chance of surgical treatment and may avoid postoperative liver failure. The concept of ALPPS has been widely recognized. The ALPPS procedure is considered to be a revolutionary breakthrough in surgical strategy or liver technology (18). It is suitable not only for radical resection of metastatic liver cancer but also for HCC and cholangiocarcinoma. At the first step of the operation, the left and right livers need to be split *in situ*; for patients with preexisting chronic liver disease, it can easily cause complications such as abnormal liver function, liver failure, or severe infections. As a result, the perioperative morbidity and mortality rates can be high in patients who have

undergone ALPPS, and the perioperative deaths are mainly caused by postoperative bile leakage and infections (19). Therefore, different surgical instruments should be used in a standard and reasonable manner during dissection, hepatectomy, hemostasis, and management of bile leakage, so as to give full play to the advantages of these instruments. The superficial hepatic tissue is cut open by conventional electric knife, and the hepatic parenchyma is dissected by the alternate application of HIFU and electrocoagulation. Blood vessels and bile ducts should be ligated by using silk sutures of the corresponding thickness according to the lumen diameters. Hemostasis can be achieved by ligation with vascular sutures or electrocoagulation. Notably, once a bile duct is transected, it should be immediately ligated with vascular sutures to avoid postoperative bile leakage. ALPPS is a challenging procedure. The operator must be well trained and, particularly, have skills and experiences in living-donor liver transplantation (LDLT). This operation is suitable for primary hospitals. ALPPS is considered to be one of the most innovative techniques in hepatobiliary surgery in recent years and has become an important part of multidisciplinary treatment for advanced liver cancer. However, as a palliative treatment, its evidence level is still low from the perspective of evidence-based medicine. Its role in treating malignancies needs to be further validated in prospective randomized controlled trials with large sample sizes. Therefore, the development of this procedure has been accompanied by controversies.

Liver transplantation still plays a key role in liver cancer surgery

Liver transplantation has been one of the most effective ways for treating end-stage liver diseases. At present, liver transplantation has been performed nationwide. While shortage of donor organs is a worldwide problem, LDLT has become a mature technique in centers with rich experiences in liver transplantation (20). In 2007, the first case of LDLT in Hunan Province was successfully carried out in our center; since then, we have performed LDLT in more than ten patients. On February 10, 2007, we successfully performed the first case of LDLT using a sibling donor in China. In addition to informed consent, whether it is safe to harvest sufficient grafts and whether there is a risk of transmission of infection from donor to recipient should be carefully evaluated. Also, the donor must understand the whole process of LDLT and overcome any possible psychological effect. Generally, the

age limit for LDLT is 18–60 years. In Western countries, liver donors must have a compatible blood type with the recipient. In Asian countries, however, due to the scarcity of donor organs, ABO-incompatible adult LDLT has achieved acceptable outcomes (21). For the safety of the donor, it is necessary to ensure that the donors have a remnant liver volume of no less than 30–35% of the estimated total liver volume, so as to avoid liver dysfunction, residual liver failure, and death; for the safety of the recipient, the graft-to-body weight ratio (GRBWR) shall be no less than 0.8%, so as to avoid small-for-size syndrome (SFSS) and early graft failure after surgery (22). However, low GRBWR may also be acceptable in patients with good performance status and mild portal hypertension.

For HCC patients undergoing liver transplantation, the recipients are typically selected based on the Hangzhou Criteria. Shortage of liver grafts for transplantation is a global problem, and the waiting time is often too long for many patients. Under such circumstance, downstaging of HCC may be performed before transplantation; that is, a series of treatment approaches are used to reduce the tumor burden, lower the stage, and thus ensure that the disease is well controlled within the transplant criteria. The downstaging therapy is mainly feasible for HCC patients who do not meet the current HCC transplantation criteria but have no large vascular (portal vein or inferior vena cava) invasion or distant metastasis (23,24). The methods of downstaging include surgery, local ablation, and TACE. The efficacy of the downstaging treatment can be evaluated by contrast-enhanced CT and MRI in combination with AFP measurement, and the assessment indicators include tumor size/number and AFP level. In addition, the combination of a variety of treatment methods can achieve better downstaging efficacy (25,26). Furthermore, for HCC patients with hepatitis B, antiviral treatment should be as initiated as early as possible before liver transplantation, hepatitis B immune globulin should be given during anhepatic phase, and the postoperative use of anti-HBV drugs can also prevent hepatitis B recurrence after transplantation. Immunosuppressive therapy and other appropriate therapies should be applied after liver transplantation to prevent tumor recurrence.

Alternative treatments for HCC

In addition to surgical treatment, many other treatments including radiotherapy, chemotherapy, ablation therapy (including radiofrequency, microwave, and cryoablation),

interventional therapy, and molecularly targeted therapy have also been widely used for HCC in different stages. The ablation is done via three approaches: percutaneous, laparoscopic, and open, and the treatment methods include chemical ablation (including intratumoral injection of anhydrous alcohol, acetic acid, etc.) and physical ablation (mainly includes radiofrequency ablation, microwave solidification, and cryoablation). In principle, ablation therapy is feasible for patients meeting the following criteria: Child-Pugh class A or B; without blood vessel, bile duct, and/or adjacent organ involvement; without distant metastasis; mass sized ≤ 5 cm (27). The patient's general condition and the tumor's biological behaviors should be thoroughly evaluated before ablation; imaging assessment should be fully performed, and appropriate imaging guidance pathway should be selected. Meanwhile, the whole treatment process should be monitored to ensure the safety and effectiveness of the ablation.

Liver biopsy may be performed before ablation, if necessary. Surgical patients routinely fast postoperatively, with their vital signs closely monitored for 4 hours. Patients should be bedridden for at least 6 hours, during which they should undergo examinations including routine blood tests and hepatic/renal function tests to avoid any infection. A second contrast-enhanced CT/MRI scans or contrast-enhanced liver ultrasound should be performed one month after ablation therapy to evaluate the ablation effectiveness. A second ablation treatment or other therapies may be applied for patients with residual tumor.

As a first-line non-radical treatment, TACE is the preferred and most effective treatment for inoperable advanced HCC (28). The main indications of TACE include: unresectable advanced HCC; after failed surgical treatment or for prevention of tumor recurrence; downstaging before tumor resection; and small liver cancer that is not suitable for surgery or the patient is unwilling to receive a surgery. After TACE treatment, if the tumor is unfeasible for surgical resection or if a combination with local ablation therapy is not feasible, a combination with sorafenib (a targeted therapy drug) may be considered to prolong TTP and OS (29,30). TACE is an effective treatment for patients with resectable HCC since it can remarkably improve the quality of life. Radiochemotherapy can also play an important role in the treatment of residual tumor and recurrence of HCC after surgery. In particular, radiotherapy can be applied for local recurrence on abdominal wall and in retroperitoneal and hilar areas. Survival benefit can also be obtained after

radiotherapy combined with hepatic arterial chemotherapy in patients with advanced HCC (31). In addition, patients with hepatitis-associated HCC should complete antiviral treatment for a full treatment course. Strict and effective control of viral replication can reduce the incidence of liver cancer.

Pay attention to the results of histopathological examinations

At present, the improvement of HCC treatment is mainly due to the advances in diagnostic techniques. In particular, the development of imaging technology enables the early detection and radical treatment of some HCC cases. In MDT, the role of the department of pathology cannot be neglected. A detailed pathology report can help clinicians to judge the disease process and predict the prognosis, guide the clinicians to establish individualized subsequent treatment protocols, and thus provide the optimal health care service to each patient. At present, the pathology report in our hospital include the following items: number of tumor, tumor size, tumor type and differentiation, any satellite lesion, any capsular invasion, any microvascular invasion (MVI) (32,33), any tumor thrombus visible to the naked eyes, resection margin, liver tissues adjacent to the tumor, and immunohistochemical findings. After reading the pathology report, the clinicians can attend a second MDT meeting to decide the subsequent treatment protocol (including the need for interventional therapy, chemotherapy, radiotherapy, targeted therapy, etc.). MDT provides a chance for specialists from different departments to share their views and opinions to decide which approach can be used as the first-line treatment and whether a single treatment or a combination of multiple treatments should be applied in the subsequent management (34). In addition, the MDT model helps to establish a consultation and case discussion system, which can help the MDT members to expand their professional knowledge and accumulate valuable clinical experiences.

Conclusions

In summary, the role of MDT in the treatment of liver cancer has increasingly become important and has become an important part of the hospital health care system. The MDT model can ensure each HCC patient to get the optimal individualized diagnosis and treatment protocol and high-quality medical services. The exchanges and

discussions among specialists from different departments can help the MDT members to follow the HCC-related evidence-based guidelines and literature and thus help the clinicians to establish and optimize the standardized and individualized treatment protocols for HCC patients.

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Footnote

Conflicts of Interest: Both authors have completed the ICMJE uniform disclosure form (available at <http://dx.doi.org/10.21037/jxym.2017.05.05>). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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References

1. Siegel RL, Miller KD, Jemal A. Cancer statistics, 2015. *CA: a cancer journal for clinicians* 2015;65:5-29.
2. Chen W, Zheng R, Baade PD, et al. Cancer statistics in China, 2015. *CA Cancer J Clin* 2016;66:115-32.
3. Roayaie S, Jibara G, Tabrizian P, et al. The role of hepatic resection in the treatment of hepatocellular cancer. *Hepatology* 2015;62:440-51.
4. El-Serag HB. Hepatocellular Carcinoma. *N Engl J Med* 2011;365:1118-27.
5. Nault JC, Villanueva A. Intratumor molecular and phenotypic diversity in hepatocellular carcinoma. *Clin Cancer Res* 2015;21:1786-8.
6. Friemel J, Rechsteiner M, Frick L, et al. Intratumor heterogeneity in hepatocellular carcinoma. *Clin Cancer Res* 2015;21:1951-61.
7. Maluccio M, Covey A. Recent progress in understanding, diagnosing, and treating hepatocellular carcinoma. *CA Cancer J Clin* 2012;62:394-9.
8. Barone C, Koeberle D, Metselaar H, et al. Multidisciplinary approach for HCC patients: hepatology for the oncologists. *Ann Oncol* 2013;24 Suppl 2:ii15-23.
9. Gish RG, Lencioni R, Di Bisceglie AM, et al. Role of the multidisciplinary team in the diagnosis and treatment of hepatocellular carcinoma. *Expert Rev Gastroenterol Hepatol* 2012;6:173-85.
10. Marrero JA. Multidisciplinary management of hepatocellular carcinoma: where are we today? *Semin Liver Dis* 2013;33 Suppl 1:S3-10.
11. Ulahannan SV, Duffy AG, McNeel TS, et al. Earlier presentation and application of curative treatments in hepatocellular carcinoma. *Hepatology* 2014;60:1637-44.
12. Yoon JH, Choi JI, Jeong YY, et al. Pre-treatment estimation of future remnant liver function using gadoxetic acid MRI in patients with HCC. *J Hepatol* 2016;65:1155-62.
13. Fang CH, Tao HS, Yang J, et al. Impact of three-dimensional reconstruction technique in the operation planning of centrally located hepatocellular carcinoma. *J Am Coll Surg* 2015;220:28-37.
14. Chen JS, Wang Q, Chen XL, et al. Clinicopathologic characteristics and surgical outcomes of hepatocellular carcinoma with portal vein tumor thrombosis. *J Surg Res* 2012;175:243-50.
15. Wang HL, Cucchetti A, Zhong JH, et al. Should hepatic resection be recommended to patients with hepatocellular carcinoma and portal vein invasion? *J Hepatol* 2016;65:1057-8.
16. Bruix J, Sherman M; American Association for the Study of Liver Diseases. Management of hepatocellular carcinoma: an update. *Hepatology* 2011;53:1020-2.
17. Clavien PA, Lillmoen KD. Associating liver partition and portal vein ligation for staged hepatectomy. *Ann Surg* 2016;263:835-6.
18. Schlegel A, Lesurtel M, Melloul E, et al. ALPPS: from human to mice highlighting accelerated and novel mechanisms of liver regeneration. *Ann Surg* 2014;260:839-46.
19. Aloia TA, Vauthey JN. Associating liver partition and portal vein ligation for staged hepatectomy (ALPPS): what is gained and what is lost? *Ann Surg* 2012;256:e9.
20. Gordon EJ, Rodde J, Skaro A, et al. Informed consent for live liver donors: A qualitative, prospective study. *J Hepatol*

- 2015; 63:838-47.
21. Trotter JF, Everhart JE. Outcomes among living liver donors. *Gastroenterology* 2012;142:207-10.
 22. Clavien PA, Lesurtel M, Bossuyt PM, et al. OLT for HCC Consensus Group. Recommendations for liver transplantation for hepatocellular carcinoma: an international consensus conference report. *Lancet Oncol* 2012;13:e11-22.
 23. Kulik L, Abecassis M. Living donor liver transplantation for hepatocellular carcinoma. *Gastroenterology* 2004;127:S277-82.
 24. Rummeler S, Bauschke A, Baerthel E, et al. ABO-Incompatible Living Donor Liver Transplantation in Focus of Antibody Rebound. *Transfus Med Hemother* 2017; 44:46-51.
 25. Bhangui P, Vibert E, Majno P, et al. Intention-to-treat analysis of liver transplantation for hepatocellular carcinoma: living versus deceased donor transplantation. *Hepatology* 2011;53:1570-9.
 26. Goldberg DS, French B, Abt PL, et al. Superior survival using living donors and donor-recipient matching using a novel living donor risk index. *Hepatology* 2014;60:1717-26.
 27. Wang W, Zhao Y, Bai W, et al. Response assessment for HCC patients treated with repeated TACE: The optimal time-point is still an open issue. *J Hepatol* 2015;63: 1530-1.
 28. Lencioni R, Llovet JM, Han G, et al. Sorafenib or placebo plus TACE with doxorubicin-eluting beads for intermediate stage HCC: The SPACE trial. *J Hepatol* 2016;64:1090-8.
 29. Yau T, Tang VY, Yao TJ, et al. Development of Hong Kong Liver Cancer staging system with treatment stratification for patients with hepatocellular carcinoma. *Gastroenterology* 2014;146:1691-700.e3.
 30. Sieghart W, Huckle F, Peck-Radosavljevic M. Transarterial chemoembolization: modalities, indication, and patient selection. *J Hepatol* 2015;62:1187-95.
 31. Barry A, Knox JJ, Wei AC, et al. Can stereotactic body radiotherapy effectively treat hepatocellular carcinoma? *J Clin Oncol* 2016;34:404-8.
 32. Roayaie S, Blume IN, Thung SN, et al. A system of classifying microvascular invasion to predict outcome after resection in patients with hepatocellular carcinoma. *Gastroenterology* 2009;137:850-5.
 33. Banerjee S, Wang DS, Kim HJ, et al. A computed tomography radiogenomic biomarker predicts microvascular invasion and clinical outcomes in hepatocellular carcinoma. *Hepatology* 2015;62:792-800.
 34. Siddique O, Yoo ER, Perumpail RB, et al. The importance of a multidisciplinary approach to hepatocellular carcinoma. *J Multidiscip Healthc* 2017;10:95-100.

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