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COMPARISON OF TRIPLE PHASE COMPUTED TOMOGRAPHY WITH ULTRASONOGRAPHY TO DETECT THE HYPER VASCULAR LIVER METASTASIS LESIONS

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ABSTRACT

Hyper-vascular liver metastasis lesions are very common in primary malignancies like colorectal and gastrointestinal cancers and constitute a significant source of diagnostic dilemma in normal clinical practice. Early and accurate identification of these lesions is critical towards proper staging of tumors, treatment and prognosis of patients. Triple Phase Computed tomography is believed to be a reliable imaging modality in detecting liver metastases due to the capability of showing vascular features in the various phases of contrast. Nonetheless, the clinical practice of it is frequently hampered by excessive cost, technical demands, and limited provision, especially in healthcare facilities with low resources. Ultrasonography on the contrary is highly accessible, noninvasive, and cheaper, however, its diagnostic capability against hyper-vascular liver lesions varies significantly and may be operator-dependent. The study set out to compare the diagnostic and patient-reported confidence of Triple Phase CT-Scan and Ultrasonography in the detection of hyper-vascular lesions of liver metastasis. Three hospitals were sampled by a cross-sectional study (20-80 years), which involved 45 patients with suspected or confirmed liver metastases. Each of the participants was subjected to both radiographic tests. The imaging findings were evaluated to obtain sensitive and specificity of each modality, and patient satisfaction and confidence were measured with the help of the structured questionnaires. These findings showed that Triple

Phase CT-Scan was effective in the number of hyper-vascular lesions detected (84.4% of cases) as compared to the detection rate of Ultrasonography (86.7%). Although the similarity was observed in the lesion detection rates, Triple Phase CT-Scan recorded a higher specificity of 64.4% versus 46.7% of Ultrasonography. Moreover, 48.9% of the patients have chosen Triple Phase CT-Scan because of better visualization of lesions and higher confidence of making a diagnosis. To sum up, Triple Phase CT-Scan is a more specific and generally reliable in diagnostic power in hyper-vascular lesions of liver metastasis. Even though the Ultrasonography is a useful tool in the first-line screening particularly in resource-constrained conditions, a combination of imaging methods can be helpful in improving diagnostic performance. Future research concerns should be on low-cost imaging approaches and patient outcomes over time with respect to early diagnosis.

1. INTRODUCTION

Hepatocellular carcinoma and secondary gastrointestinal-associated metastatic cancer of the liver are a significant health burden in the world. Together, the liver-related cancers are among the most commonly diagnosed forms of malignancies, and leading causes of cancer-related deaths across the world, after lung and colorectal cancers[1].

The micro environment around the liver offers good biological factors to implant and develop tumors. Alterations in extensive extracellular framework and active interrelations between cancerous cells and stromal elements is crucial in the survival and progression of tumors. Mesenchymal stromal cells among stromal factors have been gaining prominence as mediators of tumor angiogenesis, immune regulation, and metastasis in the liver malignancies. These interactions determine the tumor aggressiveness, vascularity, and response to therapy and it is important to note that the detection and characterization of the liver lesions must be performed accurately.

[2].

Hyper-vascular liver metastasis lesions (HVLML) constitute a severe form of hepatic metastases, which is distinguished by intensive arterial blood flow. Clinically, these lesions are important in the sense that imaging will mimic primary liver cancers, and thus, there will be difficulties in making diagnostic conclusions. HVLML must therefore be accurately identified early and upon which stage treatment choice and prognostic evaluation must be undertaken[3].

HVLML is mostly a multistage metastatic process that has a primary malignancy that is situated outside liver. The first pathway is the proliferation of tumor cells at the initial site and the second pathway is the angiogenesis that promotes the development and to raise the risk of vascular invasion among the tumor cells. Cancer cells then gain access into the systemic circulation via blood or lymphatic and tend to become lodged particularly in the liver because of its vast vascularity. After that, already developed metastatic cells invest hepatic tissues and stimulate the development of new blood vessels, causing hyper-vascular lesions that gradually deteriorate the liver function[4].

Liver metastases are more common in some parts of the world than in others; this depends on the incidence of cancer, health services in place and access to health diagnosis. Liver metastasis is one of the emerging issues in Pakistan with increasing rates of colorectal and gastrointestinal cancer and inadequate accessibility to advanced imaging in rural areas[3, 5]. Most of the patients present at advanced stages of the disease which restricts the curative treatment offered. The presence of chronic hepatitis B and C makes the diagnosis and management even more challenging as the presence of both conditions adds to the burden of primary and secondary liver malignancies.

Colorectal cancer is known to contribute about half of the total cases of liver metastasis around the world, and liver is the only site of metastasis in up to half of the patients[6]. In the selected cases, surgical resection of liver metastases has proved long-term survival rates of about 58 years, which is attributed to the early diagnosis. Hyper vascular metastases are much more common than primary liver malignancies and can manifest as multiple or in rare cases, an isolated lesion[7]. Since they are closely linked with a poor prognosis, it is necessary to conduct imaging assessment in a timely and accurate manner[8].

According to the international cancer statistics, liver cancer is considered to be one of the most fatal malignancies in the whole world, the number of new cases and deaths is in hundreds of thousands every year[8, 9]. Hepatitis caused by viruses and high incidences of gastrointestinal cancers are new and emerging factors that lead to increased burden of liver metastasis in Asian countries like Japan, China and Korea although there is an improvement in the diagnostic and the therapeutic skills[10]. The same may be noted in Western countries, such as the United States, the United Kingdom, Germany, and Australia, where early diagnosis has enhanced the picture but liver metastasis is still a significant contributor to the morbidity related to cancer[11, 12].

Imaging will be of primary importance in detection, characterization and staging of hepatic metastases. Because of the dual blood supply to the liver, malignant lesions tend to show a distorted perfusion pattern and this is where multiphasic imaging techniques were based on[13, 14]. Triple-phase computed tomography takes advantage of these vascular variabilities to distinguish between a benign and a malignant lesion to save the patient the inconvenience of undergoing multiple invasive operations and make decisions on how the lesion is treated[15].

Hyper-vascular metastases have initial arterial enrichment then washout at later stages, which can have similarity with hepatocellular carcinoma, which can be difficult to diagnose[15, 16]. Such improvements as spectral CT have facilitated the characterization of tissues, examining the differences in energy-dependent attenuation, which is useful in differentiating lesions[17, 18]. Triple-phase CT is a very sensitive and specific modality to assess hepatic tumor and it is useful especially in the preoperative planning and to assess vascular involvement[19].

Ultrasonography remains a principle of imaging because of its availability, safety, and affordability. It comes in handy particularly in the detection of initial lesions, localizing anatomy, evaluating the vascularity, and in image-guided interventions[20, 21]. Even with better characterization, ultrasonography can also be used as a first-line and complementary diagnostic method especially in resource-constrained facilities though there is an advanced imaging modality[22, 23].

2. MATERIALS AND METHODS

The study design used was a cross-sectional study with an institution of a hospital to

compare the diagnostic performance of Triple Phase Computed Tomography (CT) and Ultrasonography in detecting hyper-vascular liver metastasis lesion. The cross-sectional design allowed the evaluation of imaging results and diagnostic outcome within a specific period to be assessed without intervention or follow-up. The number of patients enrolled in the study was 45. The sample size was calculated with the help of RAOSOFT sample size calculator; expected prevalence, confidence level, and acceptable margin of error are taken into consideration. This was deemed to be adequate to test the parameters of diagnostic accuracy including sensitivity and specificity within the time scale of the study. The research was carried out in a period of four months between July and October 2024. This was sufficient because the required time was used to recruit and complete both imaging procedures of all the patients. The data were gathered at the Pakistan Institute of medical Sciences (PIMS) Hospital, Islamabad. PIMS provided advanced diagnostic imaging services and has a large number of oncology cases as it is a leading tertiary care facility and would therefore suit this study.

2.1 Sampling Technique

The convenience sampling method was non-probability. Consecutive recruitment of the patients who received an informed consent is done by meeting the inclusion criteria and were referred to liver imaging during the study period.

2.2 Imaging Modalities and Protocols.

A 16-slice CTs scanner of the brand Optima GE Healthcare was used to carry out Triple Phase CT imaging. The patients were advised to starve 4-6 hours before imaging to lessen gastrointestinal movement and maximize the enhancement of contrasts. Metallic objects were not left in order to exclude imaging artifacts. The CT protocol was composed of non-contrast, arterial and portal venous. Base line hepatic parenchyma was tested by the non-contrast stage. The intravenous contrast was given through a peripheral vein and then arterial phase imaging of 2030 seconds was taken to visualize hyper-vascular enhancement. To assess the lesion washout and the general morphology of the liver, portal venous phase imaging was received at 60-70 seconds. The patients were scanned when lying on their backs and were advised to maintain breathlessness when taking pictures. The overall time of examination was about 10-15 minutes.

2.3 Ultrasonography

The evaluation was done through ultrasonography using a 57 MHz transducer that had a frequency of 57 MHz on a Toshiba Xario XG. Fasting of patients was done 4-6 hours prior to examination so as to improve the quality of images. The scans were carried out in a supine position and with a right arm upraised.

The procedure involved gray scale scan to identify focal liver lesions, and then color Doppler to evaluate the blood flow in the liver. Lesion vascularity was assessed and hyper-vascularity features were detected using Power Doppler imaging. All the examinations took around 15-30 minutes, and patients were asked to sit still and follow the instructions of the breath-holding.

2.4 Inclusion Criteria

The study included patients aged between 20 and 80 years of any gender who had known a known primary malignancy or had clinical, laboratory, or imaging suspicion of liver metastasis.

2.5 Exclusion Criteria

Individuals who had undergone liver surgery, liver transplantation or any other hepatic surgery were excluded. Patients who had

chronic liver diseases together e.g. cirrhosis or viral hepatitis were also excluded. Patients who could not endure CT or ultrasound scan were excluded.

2.6 Data Analysis

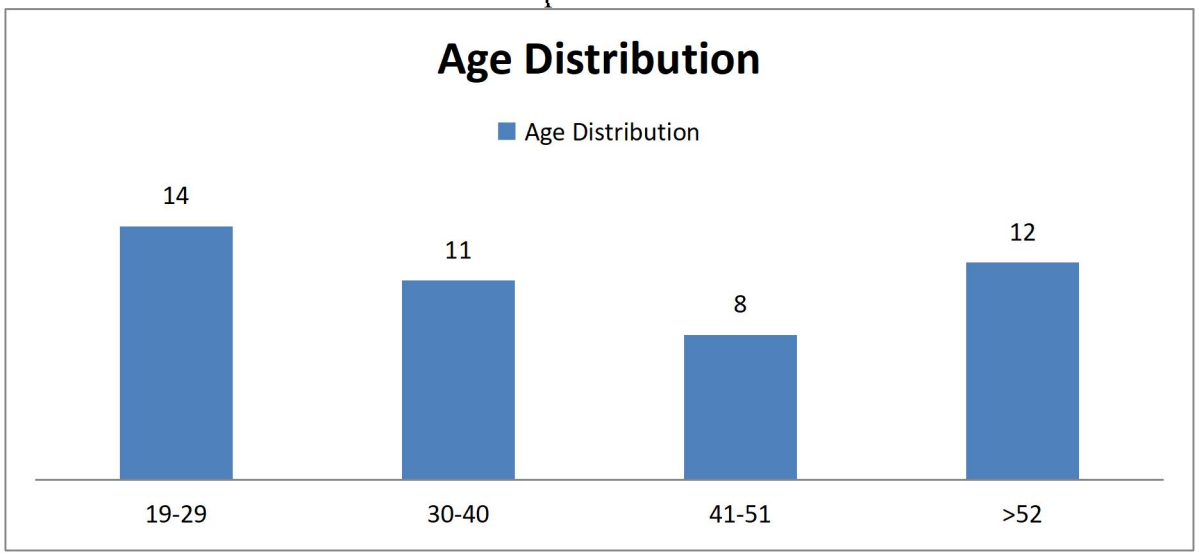
Statistical Package of Social Sciences (SPSS) version 26.0.1.0 was used to analyze the data. Demographic information was ultimately summarized with the help of descriptive statistics, and diagnostic accuracy of each imaging modality was determined.

2.7 Ethical Approval

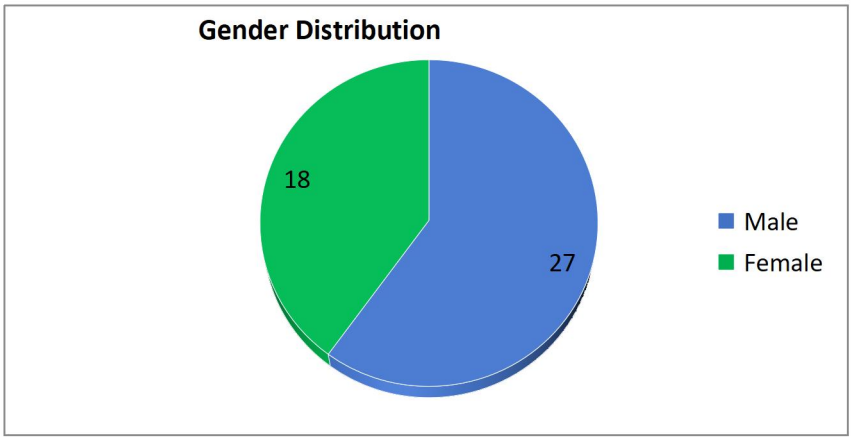
The research was done following authorization that was secured at the Hospital Internal Review Board (IRB) of PIMS Hospital. The informed consent was provided by all the participants in written form and the process of the research was conducted under a strict confidentiality.

3. RESULTS

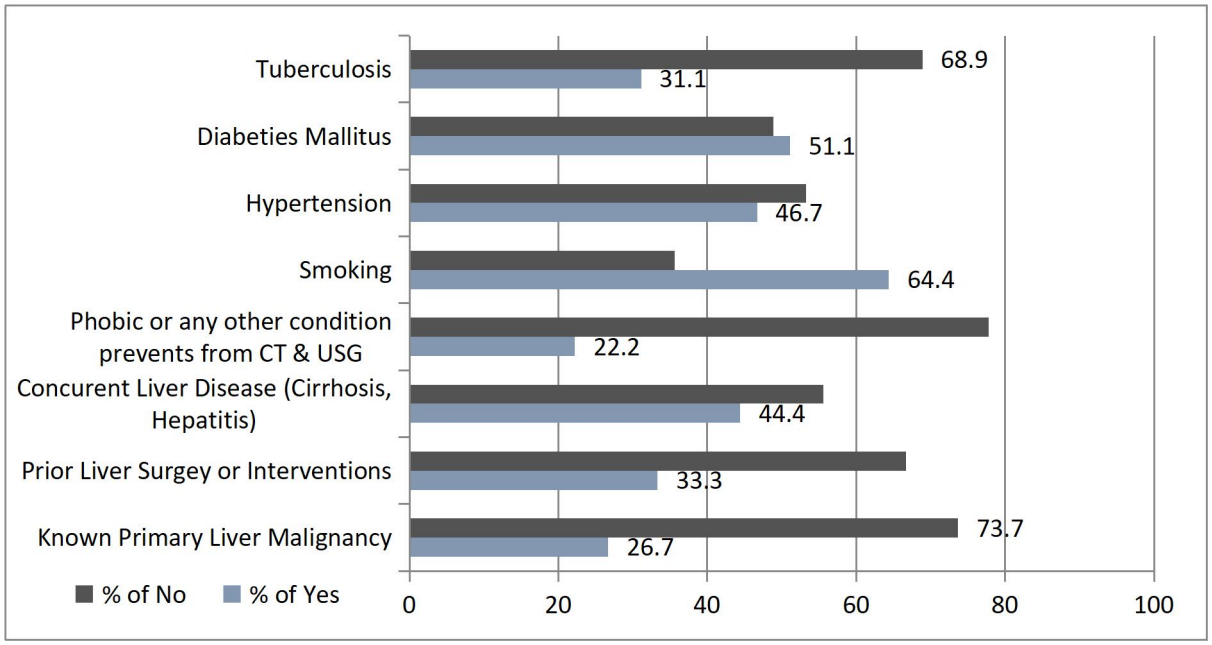
The sample size was broad in age bracket, with the highest number representing the age group of 19-29 years, then there were the 30-40 years age group and then those of above 52 years age group. The youngest age group of 41 years to 51 years had the lowest number of representations, which suggests the study sample was rather young in general.



The number of male's was 60 percent and female's 40 percent, which showed a medium level of male domination.

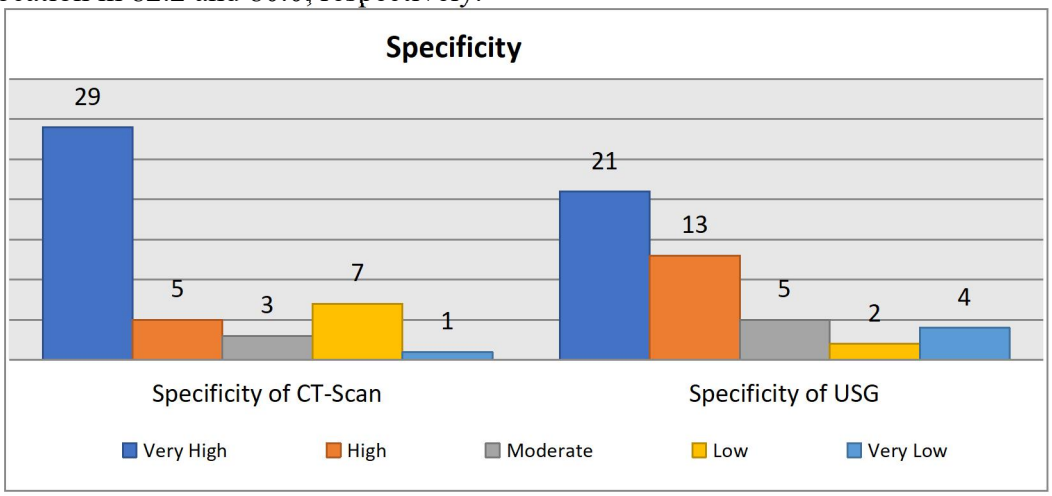


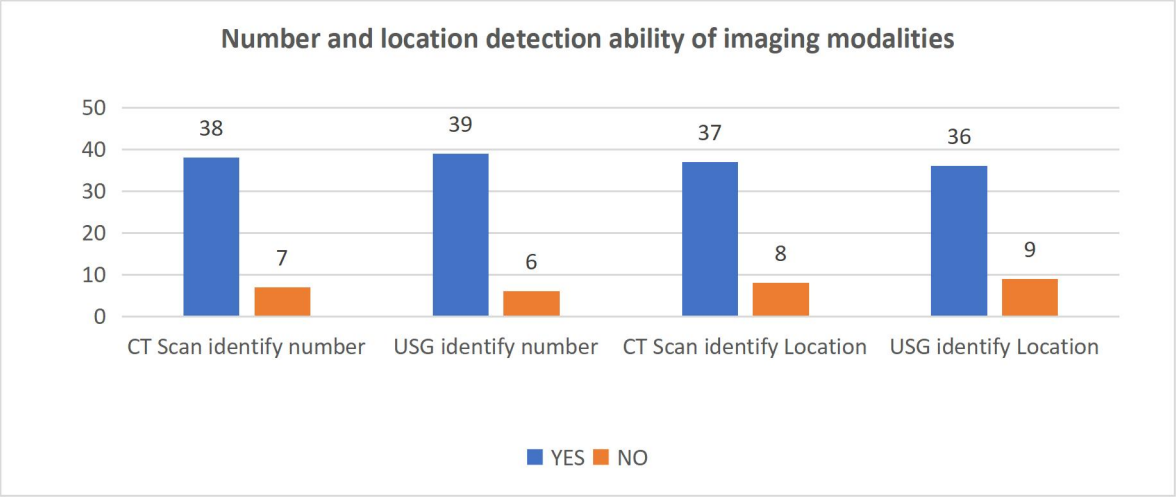
On the issue of medical history only 26.7% of the participants had known a primary malignancy, the rest had none. 33.3 percent of the patients had a history of liver surgery or intervention and 44.4 percent of the entire population of the study had co-occurring liver diseases like cirrhosis or hepatitis. Risk factors among the common ones were; smoking (64.4%), diabetes mellitus (51.1%), and high blood pressure (46.7%), with 31.1 percent reporting tuberculosis.



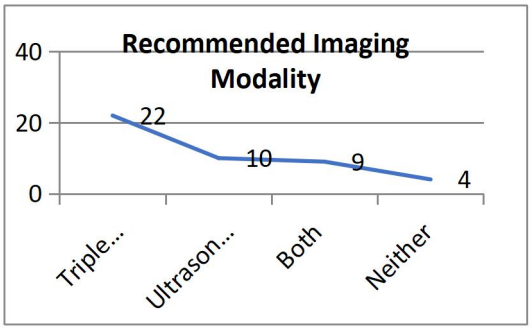
Imaging modalities assessment revealed that 84.4 of the participants indicated that Triple Phase CT-Scan correctly identified the count of hyper-vascular lesions of liver metastasis, as opposed to 86.7 with Ultrasonography. CT-Scan and Ultrasonography correctly identified lesion location in 82.2 and 80.0, respectively.

Even though the sensitivity of both modalities was similar, Triple Phase CT-Scan was ranked higher in specificity with 64.4% of the participants considering it very high in relation to Ultrasonography of 46.7%.





All in all, Triple Phase CT-Scan was suggested as a desirable imaging modality with 48.9% of the respondents, other participants preferred Ultrasonography or a combination of different forms of diagnostics.



4. DISCUSSION

This paper compares and contrasts Triple Phase CT-Scan and ultrasonography in the detection of lesions of hyper-vascular liver metastasis with clinical implications giving differences in the effectiveness, specificity and user preferences. The demographic analysis showed that most of the participants were younger than 40 years old, which is in line with the findings of other past studies that showed that liver metastases are more prevalent among younger individuals probably because of earlier detection of primary tumors or other lifestyle choices. The gender distribution being 60 percent male is in accordance with studies that show that men are more likely to be diagnosed with liver metastases more than women[24]. A significant percentage of respondents had pre-existing liver diseases (44.4%), and other traditional risk factors including smoking (64.4%) and diabetes mellitus (51.1%), which agrees with the literature that chronic liver diseases e.g. cirrhosis, and hepatitis predispose individuals to metastatic liver lesions [25].

In terms of imaging performance, Triple Phase CT-Scan was rated as very effective by 37.8% of participants who rated it as effective by 46.7% with Ultrasonography receiving very effective and effective ratings of 46.7 and 40 percent respectively (Table 4.1). The findings correspond with the literature that has indicated equity roles of the two modalities; CT-Scan will be used to provide detailed cross-sectional images to accurately localize and characterize lesions whereas Ultrasonography will be used to offer readily accessible, cost-effective, real-time images that can be used to monitor and follow up[26]. When identifying lesions, 84.4% of respondents considered CT-Scan precise with 86.7% considering Ultrasonography to be accurate (Table 4.2), which is consistent with

previous data showing that both methods are highly diagnostic with regards to anatomy, however, CT-Scan is more able to provide comprehensive assessment due to its higher anatomy[27, 28].

With regard to localization of the lesions, 82.2 percent of the participants confirmed CT-Scan as accurate, with 80 percent correspondingly indicating the same about Ultrasonography (Table 4.2). It is also established in literature that CT-Scan has better spatial resolution and better localization in complicated liver anatomy, whereas accuracy of Ultrasonography can be influenced by expertise of an operator and other patient factors like obesity[29]. The satisfaction of the participants with sensitivity was a bit higher with Ultrasonography (48.9% very satisfied) because it has real time imaging responses and that CT-Scan scored higher in specificity (64.4% very high) than Ultrasonography (46.7%), which is associated with advanced imaging technology that minimizes false positives [29].

In general, the results suggest that both modalities have the value of hyper-vascular liver metastases detection, and CT-Scan is more specific and detailed in terms of anatomy, whereas Ultrasonography is accessible, real-time, and patient-centered. An integration of the two methods that capitalize on the advantages of either can be the most effective way to enhance clinical decision-making, and therefore, it is necessary to select the modality that is individual and dependent on factors associated with patients, lesions, and available resources[30].

5. CONCLUSION

In this study, Triple Phase CT-Scan and Ultrasonography were compared in terms of detecting hyper-vascular liver metastasis lesions, and their respective strengths were identified. Triple Phase CT-Scan showed more accurate results in the numbers, locations, and characteristics of the lesions because it is a high-resolution imaging, which increases the diagnostic confidence and specificity. Although a little less accurate, ultrasonography provides real-time image, instant clinical response, and increased patient satisfaction and is useful in follow-up and monitoring. Altogether, the two modalities are complementary in clinical practice. The choice of the imaging technique to be used ought to be based on the needs of the patient, the complexity of the lesion and the resources available so as to achieve maximum diagnosis and management of liver metastases.

6. REFRENCES

1. Gopalakrishnan, M., et al., *CLINICOPATHOLOGICAL ANALYSIS OF HEPATOBILIARY MALIGNANCIES IN A TERTIARY CARE HOSPITAL–A RETROSPECTIVE STUDY.* Int J Acad Med Pharm, 2024. **6**(2): p. 1138-1145.
2. Kanwal, F., et al., *Effect of metabolic traits on the risk of cirrhosis and hepatocellular cancer in nonalcoholic fatty liver disease.* Hepatology, 2020. **71**(3): p. 808-819.
3. Zane, K.E., et al., *Metastatic disease to the liver: Locoregional therapy strategies and outcomes.* World Journal of Clinical Oncology, 2021. **12**(9): p. 725.
4. Kulinna, C. and W. Schima, *Imaging Features of Hepatic Metastases: CT and MR*, in *Focal Liver Lesions: Detection, Characterization, Ablation*. 2005, Springer. p. 275-293.
5. Komuta, M., *Histological heterogeneity of primary liver cancers: clinical relevance, diagnostic pitfalls and the pathologist's role.* Cancers, 2021. **13**(12): p. 2871.
6. Kambakamba, P., et al., *The evolution of surgery for colorectal liver metastases: A persistent challenge to improve survival.* Surgery, 2021. **170**(6): p. 1732-1740.
7. Lachance, E., et al., *Radiologic-pathologic correlation of liver tumors.* Exon Publications, 2021: p. 87-108.

8. Klein, C.A., *Cancer progression and the invisible phase of metastatic colonization.* Nature Reviews Cancer, 2020. **20**(11): p. 681-694.
9. Chowdhury, A.B. and K.J. Mehta, *Liver biopsy for assessment of chronic liver diseases: a synopsis.* Clinical and experimental medicine, 2023. **23**(2): p. 273-285.
10. Hoque, S., et al., *The Multidisciplinary Management of Primary Hepatocellular Carcinoma.* Gastrointestinal Oncology-A Critical Multidisciplinary Team Approach 2e, 2024: p. 321-346.
11. Engstrand, J., et al., *Colorectal cancer liver metastases–a population-based study on incidence, management and survival.* BMC cancer, 2018. **18**(1): p. 78.
12. Saba, L. and J.S. Suri, *Multi-Detector CT Imaging Handbook, Two Volume Set*. 2022: CRC Press.
13. D'Antiga, L., *Pediatric hepatology and liver transplantation*. 2019: Springer.
14. Quaia, E., *Imaging of the Liver and Intra-hepatic Biliary Tract*. 2020: Springer.
15. Renzulli, M., et al., *Imaging-based diagnosis of benign lesions and pseudolesions in the cirrhotic liver.* Magnetic Resonance Imaging, 2021. **75**: p. 9-20.
16. Yang, Z., X. Wang, and H. Shi, *Quantitative Analysis of Hypervascular Hepatic Metastases and Hepatocellular Carcinoma using Spectral CT Imaging.* 2020.
17. Pogue, B.W., et al., *Review of in vivo optical molecular imaging and sensing from x-ray excitation.* Journal of Biomedical Optics, 2021. **26**(1): p. 010902-010902.
18. Zhang, Y., et al., *Applications of hyperspectral imaging in the detection and diagnosis of solid tumors.* Translational Cancer Research, 2020. **9**(2): p. 1265.
19. uz Zaman, M., *ABSTRACTS OF 39th RSP ANNUAL CONFERENCE (8-10TH DEC 2023-QUETTA).* Pakistan Journal of Radiology, 2023. **33**(4).
20. Zahur, Z., et al., *Transabdominal ultrasound: a potentially accurate and useful tool for detection of choledocholithiasis.* Journal of Ayub Medical College Abbottabad, 2019. **31**(4): p. 572-575.
21. Debela, D.T., et al., *New approaches and procedures for cancer treatment: Current perspectives.* SAGE open medicine, 2021. **9**: p. 20503121211034366.
22. Hussain, S., et al., *Modern diagnostic imaging technique applications and risk factors in the medical field: a review.* BioMed research international, 2022. **2022**(1): p. 5164970.
23. Mavilia, M.G., et al., *Differentiating cystic liver lesions: a review of imaging modalities, diagnosis and management.* Journal of clinical and translational hepatology, 2018. **6**(2): p. 208.
24. Pinheiro, P.S., et al., *Incidence of etiology-specific hepatocellular carcinoma: diverging trends and significant heterogeneity by race and ethnicity.* Clinical gastroenterology and hepatology, 2024. **22**(3): p. 562-571. e8.
25. Carroll, A.S. and N.G. Simon, *Current and future applications of ultrasound imaging in peripheral nerve disorders.* World Journal of Radiology, 2020. **12**(6): p. 101.
26. Pal, A., et al., *Comprehensive literature review on the radiographic findings, imaging modalities, and the role of radiology in the COVID-19 pandemic.* World Journal of Radiology, 2021. **13**(9): p. 258.
27. Reda, R., et al., *Ultrasound imaging in dentistry: a literature overview.* Journal of imaging, 2021. **7**(11): p. 238.
28. Fiz, F., et al., *Radiomics of liver metastases: a systematic review.* Cancers, 2020. **12**(10): p. 2881.
29. Lwin, T.M., R.M. Hoffman, and M. Bouvet, *Fluorescence-guided hepatobiliary surgery with long and short wavelength fluorophores.* Hepatobiliary Surgery and Nutrition, 2020. **9**(5): p. 615.
30. Albrecht, T., et al., *Imaging of liver metastases with contrast-specific low-MI real-time ultrasound and SonoVue.* European radiology, 2003. **13**(Suppl 3): p. N79-N86.