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Histopathology of Liver Biopsy in Modern Clinical Practice

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ABSTRACT

Background: The histopathology of liver biopsies has evolved significantly due to advancements in diagnostic techniques and a better understanding of liver diseases. **Literature Review:** In the context of hepatocellular carcinoma (HCC), the necessity of liver biopsy remains pronounced, despite advancements in imaging technologies. (Sparchez & Mocan, 2018) highlights the essential role of liver biopsy in accurately diagnosing HCC, particularly in cirrhotic patients where imaging results can be inconclusive. The integration of histological and molecular characterizations is crucial for informing treatment decisions, as advanced imaging alone may not suffice for definitive diagnosis. The challenges presented by advanced disease stages and the limitations of imaging are further explored by (Rastogi, 2018). This article underscores the importance of tissue analysis for accurate diagnosis and prognostic assessment, despite the risks associated with biopsy procedures. The potential for tissue biomarkers and molecular signatures to enhance clinical decision-making is also highlighted, reinforcing the ongoing relevance of histopathology in managing HCC. The introduction of digital pathology and whole slide imaging (WSI) has been examined by (C. N. Melo et al., 2020), who argue that these technologies improve the accuracy and objectivity of histopathological assessments. WSI allows for detailed morphological analysis and quantification of histological parameters, which can significantly aid in understanding liver diseases. **Conclusions:** In conclusion, the literature collectively highlights the dynamic landscape of liver histopathology, emphasizing the integration of traditional techniques with modern technological advancements to enhance diagnostic accuracy and therapeutic decision-making in clinical practice. The ongoing relevance of liver biopsy, despite technological shifts, remains paramount in providing comprehensive patient management, particularly in complex clinical scenarios.

Keywords: Histopathology, Liver Biopsy, Modern Clinical Practice

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INTRODUCTION

The histopathology of liver biopsies has undergone significant evolution over the past two decades, reflecting advancements in diagnostic techniques and a deeper understanding of liver diseases. The early work by (Spycher et al., 2001) emphasized the shifting role of liver biopsy in the era of molecular diagnostics, where the primary utility of biopsy was reassessed to focus mainly on staging rather than diagnostic purposes. Their review of liver biopsies conducted five years post-introduction of hepatitis C testing highlighted the residual diagnostic insights that could still be gleaned from histopathological evaluation, illustrating the need for a nuanced understanding of liver pathology.

As the field progressed, (Sparchez & Mocan, 2018) reconsidered the role of liver biopsy specifically in the context of hepatocellular carcinoma (HCC). They noted that while imaging technologies have advanced, liver biopsy remains essential for accurate diagnosis and management of HCC, particularly given the complexity of identifying focal liver lesions in cirrhotic patients. Their findings underscored the importance of integrating histological and molecular characterizations to inform treatment decisions, as well as the necessity of liver biopsy when imaging results are inconclusive.

(Rastogi, 2018) further examined the critical role of liver biopsy in HCC, addressing the challenges posed by advanced disease presentation and the limitations of imaging alone. Despite the risks associated with biopsy, including complications and interpretative errors, the need for tissue analysis remained paramount for accurate diagnosis and prognostic assessment. (Rastogi, 2018)'s work highlighted the potential of tissue biomarkers and molecular signatures to enhance clinical decision-making, reinforcing the necessity of histopathological evaluation in managing HCC.

The introduction of digital pathology and whole slide imaging (WSI) was explored by (C. N. Melo et al., 2020), who discussed how these technologies can enhance the accuracy and objectivity of histopathological assessments. By digitizing

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histological specimens, WSI allows for detailed morphological analysis and quantification of histological parameters, which can significantly aid in the diagnostic process and understanding of liver diseases.

Guidelines established by (Neuberger et al., 2020) provided a systematic approach to liver biopsy interpretation, emphasizing the importance of comprehensive clinical information and thorough histological descriptions. Their review highlighted the critical role of pathologists in ensuring accurate diagnoses and managing discrepancies in liver biopsy results, thereby reinforcing the need for standardized practices in clinical settings.

(Elazab et al., 2020) examined the application of machine learning techniques to histopathological images, proposing that computer-aided diagnosis (CAD) systems could enhance diagnostic reliability. By automating image analysis and reducing variability in interpretations, these technologies have the potential to transform histopathological evaluations and improve patient outcomes.

(Komuta, 2021) focused on the histological heterogeneity of primary liver cancers, emphasizing the importance of accurate subtyping for predicting tumor behavior and guiding treatment. The study advocated for a comprehensive pathological approach to ensure consistent diagnoses, which is essential for establishing effective treatment strategies based on molecular profiling.

Finally, (Gambella et al., 2022) discussed the emerging possibilities in liver histomorphologic evaluation within pediatric liver transplantation. They highlighted the potential of next-generation pathology, which combines advanced immunohistochemistry techniques with digital analysis to provide detailed insights into cellular characteristics and spatial organization within liver biopsies. This innovative approach promises to redefine the indications for liver biopsy, particularly in complex clinical scenarios.

Together, these articles illustrate the dynamic landscape of liver histopathology, emphasizing the integration of traditional techniques with modern technological

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advancements to enhance diagnostic accuracy and therapeutic decision-making in clinical practice.

LITERATURE REVIEW

The article "The diagnostic value of liver biopsy" by (Spycher et al., 2001) presents a critical evaluation of the role of liver biopsy in the context of evolving diagnostic technologies, particularly following the introduction of molecular diagnostic tools for hepatitis C. The authors argue that while liver biopsy has traditionally been a cornerstone in the diagnosis and management of liver diseases, its role has shifted primarily towards staging rather than diagnostic purposes.

The study meticulously reviews liver biopsies conducted over a five-year period post the introduction of hepatitis C serological testing. The authors highlight that the advent of molecular diagnostics has significantly altered the landscape of liver disease management, leading to a decreased reliance on biopsy for definitive diagnosis. This shift raises important questions about the ongoing utility of liver biopsies in clinical practice, especially in cases where serological tests can provide sufficient diagnostic information.

(Spycher et al., 2001) emphasizes that despite the advancements in serological testing, liver biopsy still provides valuable insights, particularly in cases where the histopathological evaluation can reveal the extent of liver damage or fibrosis that serological tests alone may not fully capture. The article presents a balanced view, acknowledging that while serological markers have improved diagnostic accuracy for hepatitis C, the histopathological assessment remains crucial for comprehensive patient management, especially in determining the appropriate therapeutic interventions.

Moreover, the authors critically assess the limitations of relying solely on serological testing, such as potential misinterpretations and the inability to assess the histological architecture of the liver. They advocate for a continued role of liver biopsy in specific clinical scenarios where detailed histopathological information is essential for guiding treatment decisions.

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The article "Contemporary role of liver biopsy in hepatocellular carcinoma" by (Sparchez & Mocan, 2018) presents a critical examination of the evolving role of liver biopsy in the diagnosis and management of hepatocellular carcinoma (HCC). The authors assert that despite advancements in imaging technologies, liver biopsy remains a vital component in the clinical approach to HCC, particularly in the context of accurately identifying focal liver lesions in cirrhotic patients.

One of the key insights from the article is the impact of high-throughput molecular technologies on the understanding of HCC. The authors highlight that these technologies have facilitated the characterization of various HCC subtypes through both molecular and histological methods. Each subtype exhibits distinct molecular patterns and prognostic implications, underscoring the importance of liver biopsy in tailoring patient management strategies. This perspective is particularly relevant given the complexity of HCC and the necessity for precise prognostic information to guide therapeutic decisions.

The article also emphasizes the challenges associated with the identification of small focal liver lesions, which can often be missed by imaging alone. The authors note that advancements in ultrasound, particularly the use of contrast-enhanced ultrasound (CEUS), have improved the detection of these lesions. CEUS is portrayed as a valuable adjunct to conventional ultrasound, providing a rapid and effective imaging modality that can enhance the diagnostic pathway for HCC patients. However, the authors caution that while CEUS may aid in lesion identification, the definitive diagnosis often still relies on histological confirmation through liver biopsy, particularly in cases where imaging results are inconclusive.

Furthermore, the article discusses the guidelines set forth by the American Association for the Study of Liver Diseases (AASLD) and the European Association for the Study of the Liver (EASL), which advocate for liver biopsy in scenarios where imaging findings are ambiguous. This recommendation reinforces the notion that liver biopsy is not only a diagnostic tool but also a means of obtaining prognostic information that can inform treatment selection.

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The article "Changing role of histopathology in the diagnosis and management of hepatocellular carcinoma" by (Rastogi, 2018) provides a comprehensive examination of the evolving significance of histopathology in the context of hepatocellular carcinoma (HCC), a prevalent and lethal cancer globally. (Rastogi, 2018) highlights that HCC often presents at advanced stages, which complicates treatment options and results in a dismal prognosis. This underscores the crucial role that liver biopsy plays in both the diagnosis and prognosis of HCC.

(Rastogi, 2018) notes that clinical guidelines have increasingly restricted the application of liver biopsy to specific circumstances, which raises questions about the broader implications for patient management. The author discusses the inherent challenges associated with liver biopsy, including the risks of needle tract seeding, complications, and technical errors that can lead to sampling inaccuracies. These concerns are critical, as they may deter clinicians from utilizing biopsy as a diagnostic tool despite its potential benefits.

Moreover, the article emphasizes the necessity of tissue analysis in instances where imaging alone fails to provide definitive information. This is particularly relevant for clinical trials involving novel pharmacological interventions and targeted therapies, where biopsy confirmation is often mandated. The author further elaborates on the importance of tissue biomarkers and morphological characteristics that serve as prognostic indicators, reinforcing the ongoing relevance of histopathology in HCC management.

In addition, (Rastogi, 2018) discusses advancements in cancer biology and the molecular classification of HCC, which have led to the identification of phenotypic surrogates that correlate with significant molecular signatures. This development is pivotal as it not only enhances the understanding of HCC's biological behavior but also aids in tailoring therapeutic strategies based on individual patient profiles.

The article "Whole Slide Imaging and Its Applications to Histopathological Studies of Liver Disorders" by (C. N. Melo et al., 2020) provides a comprehensive overview of the advancements in digital pathology, particularly focusing on whole slide imaging (WSI) and its implications for the histological evaluation of liver disorders.

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The authors emphasize the critical role that histological examination of hepatic tissue specimens plays in diagnosing and grading liver diseases. They argue that distinctive microscopic features of the liver are essential for differential diagnosis, which in turn guides therapeutic decisions.

One of the key insights presented in the article is the limitation of traditional manual examination of histological slides. The authors highlight that such evaluations are not only time-consuming but also semi-quantitative, which can hinder the accuracy and efficiency of diagnoses. This critique underscores the need for more robust methodologies that can enhance the precision of histopathological assessments. The introduction of WSI is positioned as a significant advancement that addresses these limitations. By digitally scanning entire histologic sections and producing high-resolution images, WSI facilitates a more comprehensive analysis of liver tissue.

The article further discusses how WSI allows for the quantification of various histological parameters, thereby providing deeper insights into disease pathogenesis and tissue biology. This capability is particularly important in the context of liver disorders, where understanding the intricate details of tissue structure and function can lead to improved diagnostic accuracy and better-informed treatment strategies. The authors effectively argue that the transition from conventional microscopy to digital pathology represents a paradigm shift in histopathological practices, particularly in the context of liver diseases.

Moreover, the review addresses the current status of WSI technology as applied to liver pathology, noting its potential applications in both clinical and research settings. The authors provide a critical evaluation of the existing literature on WSI, suggesting that while there is a growing body of evidence supporting its efficacy, further studies are necessary to standardize its application and validate its clinical utility.

The article "Guidelines on the use of liver biopsy in clinical practice from the British Society of Gastroenterology, the Royal College of Radiologists and the Royal College of Pathology" by (Neuberger et al., 2020) provides a comprehensive overview of the critical role that liver biopsy plays in contemporary clinical

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practice, particularly in the context of transplant centers and the management of chronic liver diseases.

One of the key insights from the article is the emphasis on the necessity of a review service for transplant biopsies conducted at different facilities. This is particularly significant given the findings from Bejarano, which indicated that major discrepancies in diagnoses occurred in 28% of cases, potentially impacting patient management ((Neuberger et al., 2020)). Such discrepancies highlight the importance of having a standardized approach to the interpretation of liver biopsies, particularly in complex cases where the clinical picture may not align with histological findings.

The authors underscore the importance of several factors in the evaluation of liver biopsy specimens, including the adequacy of the biopsy, which should be assessed by the length of the biopsy core, the number of fragments, and the presence of portal tracts per section. This aspect is crucial as inadequate samples can lead to misinterpretation of the disease severity and progression ((Neuberger et al., 2020)). Furthermore, the article discusses the architectural changes indicative of chronic liver disease, such as fibrosis severity, distortion of hepatocyte architecture, and parenchymal nodularity. These histological features are vital for diagnosing conditions like cirrhosis and bridging fibrosis.

Moreover, the article advocates for a systematic approach to describing histological abnormalities, including the use of special stains where appropriate. This systematic description is essential not only for accurate diagnosis but also for providing a clear communication channel between pathologists and clinicians regarding the morphological patterns of liver disease ((Neuberger et al., 2020)). The authors also stress the importance of comparing current biopsy results with any previous biopsies, which can provide valuable context for understanding disease progression or response to treatment.

The article titled "Objective Diagnosis for Histopathological Images Based on Machine Learning Techniques: Classical Approaches and New Trends" by (Elazab et al., 2020) presents a comprehensive examination of the application of machine

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learning (ML) techniques in the analysis of histopathological images. The authors emphasize the inherent complexity of histopathological images (HI), which contain both natural and abnormal biological structures, alongside morphological and architectural features that pathologists traditionally rely upon for diagnosis.

A critical insight from the article is the recognition of variability in diagnosis and treatment that arises from the subjective interpretation of histopathological images. The authors argue that this variability can be mitigated through the implementation of computer-aided diagnosis (CAD) systems, which offer an objective framework for analyzing these images. This is particularly relevant in the context of liver biopsies, where precise diagnosis is crucial for determining the appropriate treatment plan. By employing CAD techniques, the authors suggest that the reliability of classification can be significantly enhanced, as these systems are designed to analyze each pixel in whole slide images (WSI), thereby reducing the likelihood of oversight that may occur during manual examination.

The article also highlights the distinction between errors produced by ML algorithms and those made by human pathologists. This distinction is critical in understanding the potential for ML to complement, rather than replace, the expertise of pathologists. The authors note that while ML can improve diagnostic accuracy, it is essential to consider the limitations and challenges associated with these technologies, including the need for robust training datasets and the potential for algorithmic bias.

Furthermore, the authors detail various tasks within electronic HI analysis that are integral to CAD systems, such as the recognition and segmentation of regions of interest (ROI). These tasks are fundamental to enhancing the diagnostic process, as they allow for a more focused analysis of specific areas within the histopathological images. The article effectively illustrates how the integration of ML techniques into clinical practice can lead to more objective and reliable diagnoses, particularly in complex cases such as those involving liver pathology.

In the article "Histological Heterogeneity of Primary Liver Cancers: Clinical Relevance, Diagnostic Pitfalls and the Pathologist’s Role," (Komuta, 2021)

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provides a comprehensive examination of the critical role of pathological diagnosis in the management of primary liver cancers. The author emphasizes that accurate subtyping of tumors is not merely an academic exercise but a fundamental aspect that influences treatment decisions and prognostic predictions.

One of the key insights presented is the correlation between tumor subtype and aggressiveness, particularly in hepatocellular carcinoma (HCC). The article highlights that specific subtypes, such as the macrotrabecular-massive type, exhibit distinct behaviors that can significantly impact patient outcomes. This underscores the necessity for pathologists to be adept in recognizing these subtypes, as their identification directly informs therapeutic strategies ((Komuta, 2021)).

The discussion extends to the importance of distinguishing between intrahepatic cholangiocarcinoma (iCCA) and metastatic tumors, as well as differentiating small duct iCCA from combined hepatocellular-cholangiocarcinoma (cHCC-CCA). (Komuta, 2021) stresses that such distinctions are not only critical for diagnosis but also pivotal for tailoring treatment approaches. The author advocates for a comprehensive diagnostic strategy, particularly when clinical and pathological features are discordant, thereby highlighting the need for pathologists to integrate clinical data with histological findings ((Komuta, 2021)).

Moreover, the article points out the significance of molecular profiling in the classification of liver tumors. The identification of actionable mutations is framed as a crucial component in the management of aggressive tumors, suggesting that a morpho-molecular classification system could enhance diagnostic accuracy and treatment efficacy. This aspect of the article resonates with the current trend in oncology towards personalized medicine, where understanding the molecular landscape of tumors can lead to more targeted therapies ((Komuta, 2021)).

(Komuta, 2021) also emphasizes the importance of adhering to the latest WHO classification for tumor diagnosis, cautioning against reliance on outdated classifications which may lead to diagnostic inaccuracies. This call for standardization in diagnostic practices is particularly relevant in the context of liver biopsies, where the heterogeneity of tumors can complicate interpretation.

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The article titled "Not only a small liver - The pathologist's perspective in the pediatric liver transplant setting" by (Gambella et al., 2022) presents a compelling examination of the evolving role of liver biopsy in the context of pediatric liver transplantation (PLTx). The authors argue that we are on the cusp of a transformative era in liver histomorphologic evaluation, driven by advancements in pathology techniques that enhance our understanding of liver tissue at a cellular level.

One of the central themes of the article is the acknowledgment of the inherent risks associated with liver biopsy, which can lead to significant complications. Despite these risks, the authors advocate for the continued use of liver biopsy, particularly in PLTx, by emphasizing the potential of next-generation pathology techniques. They highlight how these advancements can provide detailed insights into single-cell morphometric, phenotypic, and spatial characteristics of liver tissue, thereby enriching the data obtained from biopsies and correlating it with tissue architecture.

A notable innovation discussed in the article is multiplex immunohistochemistry, which allows for the simultaneous evaluation of multiple antigens within a single slide. This technique is particularly valuable for discerning the specific phenotypes of immune cells, which is crucial for understanding the immunological landscape of the liver in transplant settings. The authors illustrate how this method can uncover intricate details that traditional histopathology might overlook, thus enhancing diagnostic accuracy and guiding therapeutic decisions.

Furthermore, the article emphasizes the role of digital analysis in liver biopsy interpretation. By applying advanced computational techniques to morphologic and spatial data, pathologists can uncover patterns and relationships that were previously unexplored. This capability not only enhances the diagnostic power of liver biopsies but also facilitates the identification of patients who may benefit from tailored immunosuppression strategies, such as weaning off immunosuppressive therapy.

CONCLUSION

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The histopathology of liver biopsies has evolved significantly due to advancements in diagnostic techniques and a better understanding of liver diseases. The role of liver biopsy has shifted primarily towards staging rather than diagnostic purposes, particularly following the introduction of molecular diagnostics for hepatitis C, as discussed by (Spycher et al., 2001). Despite this shift, the authors emphasize that histopathological evaluations continue to provide valuable insights into liver damage and fibrosis that serological tests alone may not capture.

In the context of hepatocellular carcinoma (HCC), the necessity of liver biopsy remains pronounced, despite advancements in imaging technologies. (Sparchez & Mocan, 2018) highlights the essential role of liver biopsy in accurately diagnosing HCC, particularly in cirrhotic patients where imaging results can be inconclusive. The integration of histological and molecular characterizations is crucial for informing treatment decisions, as advanced imaging alone may not suffice for definitive diagnosis.

The challenges presented by advanced disease stages and the limitations of imaging are further explored by (Rastogi, 2018). This article underscores the importance of tissue analysis for accurate diagnosis and prognostic assessment, despite the risks associated with biopsy procedures. The potential for tissue biomarkers and molecular signatures to enhance clinical decision-making is also highlighted, reinforcing the ongoing relevance of histopathology in managing HCC.

The introduction of digital pathology and whole slide imaging (WSI) has been examined by (C. N. Melo et al., 2020), who argue that these technologies improve the accuracy and objectivity of histopathological assessments. WSI allows for detailed morphological analysis and quantification of histological parameters, which can significantly aid in understanding liver diseases.

Guidelines established by (Neuberger et al., 2020) provide a systematic approach to liver biopsy interpretation, emphasizing the importance of thorough clinical information and histological descriptions. This underscores the critical role of pathologists in ensuring accurate diagnoses and managing discrepancies in liver biopsy results.

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Moreover, the application of machine learning techniques to histopathological images, as discussed by (Elazab et al., 2020), has the potential to enhance diagnostic reliability through computer-aided diagnosis systems. These technologies aim to reduce variability in interpretations and improve diagnostic accuracy.

The histological heterogeneity of primary liver cancers is addressed by (Komuta, 2021), emphasizing the importance of accurate subtyping for predicting tumor behavior and guiding treatment strategies. A comprehensive pathological approach is advocated to ensure consistent diagnoses, essential for effective treatment based on molecular profiling.

Finally, (Gambella et al., 2022) discusses the emerging possibilities in liver histomorphologic evaluation within pediatric liver transplantation, emphasizing the potential of next-generation pathology techniques to provide detailed insights into cellular characteristics and spatial organization within liver biopsies.

In conclusion, the literature collectively highlights the dynamic landscape of liver histopathology, emphasizing the integration of traditional techniques with modern technological advancements to enhance diagnostic accuracy and therapeutic decision-making in clinical practice. The ongoing relevance of liver biopsy, despite technological shifts, remains paramount in providing comprehensive patient management, particularly in complex clinical scenarios.

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REFERENCES

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1. Spycher, C., Zimmermann, A., & Reichen, J., 2001. The diagnostic value of liver biopsy. ncbi.nlm.nih.gov
2. Sparchez, Z. & Mocan, T., 2018. Contemporary role of liver biopsy in hepatocellular carcinoma. ncbi.nlm.nih.gov
3. Rastogi, A., 2018. Changing role of histopathology in the diagnosis and management of hepatocellular carcinoma. ncbi.nlm.nih.gov
4. C. N. Melo, R., W. D. Raas, M., Palazzi, C., H. Neves, V., K. Malta, K., & P. Silva, T., 2020. Whole Slide Imaging and Its Applications to Histopathological Studies of Liver Disorders. ncbi.nlm.nih.gov
5. Neuberger, J., Patel, J., Caldwell, H., Davies, S., Hebditch, V., Hollywood, C., Hubscher, S., Karkhanis, S., Lester, W., Roslund, N., West, R., I Wyatt, J., & Heydtmann, M., 2020. Guidelines on the use of liver biopsy in clinical practice from the British Society of Gastroenterology, the Royal College of Radiologists and the Royal College of Pathology. ncbi.nlm.nih.gov
6. Elazab, N., Soliman, H., El-Sappagh, S., M. Riazul Islam, S., & Elmogy, M., 2020. Objective Diagnosis for Histopathological Images Based on Machine Learning Techniques: Classical Approaches and New Trends. [PDF]
7. Komuta, M., 2021. Histological Heterogeneity of Primary Liver Cancers: Clinical Relevance, Diagnostic Pitfalls and the Pathologist's Role. ncbi.nlm.nih.gov
8. Gambella, A., Mastracci, L., Caporalini, C., Francalanci, P., Mescoli, C., Ferro, J., Alaggio, R., & Grillo, F., 2022. Not only a small liver - The pathologist's perspective in the pediatric liver transplant setting. ncbi.nlm.nih.gov

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