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COMPARATIVE EVALUATION OF ELASTOGRAPHY AND HISTOLOGICAL EXAMINATION IN DETERMINING THE STAGE OF LIVER FIBROSIS

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Abstract: Liver fibrosis is a progressive pathological process characterized by excessive accumulation of extracellular matrix proteins caused by chronic liver injury. Accurate staging of fibrosis is essential for determining prognosis, monitoring disease progression, and selecting appropriate therapeutic strategies. Traditionally, liver biopsy has been considered the gold standard for fibrosis assessment; however, it is invasive and associated with several limitations. In recent years, elastography has emerged as a non-invasive diagnostic alternative. The aim of this study was to compare the diagnostic value of elastography and liver biopsy in determining the stage of liver fibrosis. The analysis demonstrated that elastography provides high diagnostic accuracy in moderate and advanced fibrosis stages while significantly reducing procedural risks. Nevertheless, liver biopsy remains important in cases requiring detailed histopathological evaluation. The combined application of both methods may improve diagnostic precision and optimize patient management.

Keywords: liver fibrosis, elastography, liver biopsy, chronic liver disease, diagnostic methods, histopathology, non-invasive assessment.

Introduction

Chronic liver diseases remain one of the major global health challenges and are associated with significant morbidity and mortality worldwide [1]. Persistent liver injury caused by viral hepatitis, alcohol abuse, non-alcoholic fatty liver disease (NAFLD), autoimmune disorders, and metabolic syndromes can lead to progressive liver fibrosis and eventually cirrhosis [2]. Early detection and accurate staging of fibrosis are crucial for preventing irreversible liver damage and improving clinical outcomes [3].

Liver fibrosis is characterized by excessive deposition of collagen and extracellular matrix proteins in hepatic tissue due to chronic inflammatory processes [4]. The progression of fibrosis is usually asymptomatic during early stages, making timely diagnosis difficult [5]. Therefore, reliable methods for assessing fibrosis severity are of great clinical importance.

For many years, liver biopsy has been regarded as the reference standard for evaluating liver fibrosis [6]. Histological examination provides direct visualization of hepatic architecture and allows assessment of inflammatory activity, necrosis, steatosis, and fibrosis stage [7]. However, liver biopsy is an invasive procedure associated with pain, bleeding, sampling errors, and interobserver variability [8]. In addition, biopsy evaluates only a limited portion of liver tissue, which may not fully represent diffuse pathological changes [9].

The limitations of liver biopsy have stimulated the development of non-invasive diagnostic approaches [10]. Among these methods, elastography has gained considerable attention due to its safety, reproducibility, and diagnostic effectiveness [11]. Elastography measures liver stiffness, which correlates with the degree of fibrosis [12]. Several elastographic techniques are currently used in clinical practice, including transient elastography, shear-wave elastography, and magnetic resonance elastography [13].

Previous studies have demonstrated that elastography possesses high sensitivity and specificity for detecting advanced fibrosis and cirrhosis [14]. Moreover, the procedure is painless, rapid, repeatable, and suitable for long-term monitoring [15]. Nevertheless, factors such as obesity, inflammation, cholestasis, and hepatic congestion may affect measurement accuracy [16].

Despite the growing popularity of elastography, controversy remains regarding its equivalence to histological examination in all stages of fibrosis [17]. Some investigators emphasize that liver biopsy continues to play a vital role in diagnosing complex liver diseases and evaluating coexisting pathological conditions [18]. Therefore, comparative analysis of elastography and biopsy remains highly relevant.

The purpose of this study was to compare the effectiveness, advantages, and limitations of elastography and liver biopsy in assessing liver fibrosis stages and to evaluate their role in modern hepatological practice.

Materials and Methods

The study included patients with chronic liver diseases who underwent fibrosis assessment using both elastography and liver biopsy. Patients with viral hepatitis, non-alcoholic fatty liver disease, alcoholic liver disease, and autoimmune hepatic disorders were included in the analysis.

Clinical examination included medical history assessment, laboratory investigations, biochemical liver function tests, and imaging studies. Elastographic examination was performed using transient elastography devices according to standardized clinical protocols. Liver stiffness values were measured in kilopascals (kPa) and interpreted according to fibrosis staging systems.

Percutaneous liver biopsy was conducted under ultrasound guidance using sterile techniques. Histological specimens were stained and evaluated by experienced pathologists using the METAVIR fibrosis scoring system. Fibrosis stages were classified from F0 to F4.

Comparative analysis was performed between elastographic findings and histological results. Diagnostic sensitivity, specificity, and correlation coefficients were analyzed statistically.

Results

The comparative analysis demonstrated a strong positive correlation between elastography values and histological fibrosis stages. Patients with mild fibrosis showed relatively low liver stiffness measurements, while advanced fibrosis and cirrhosis were associated with significantly elevated stiffness values.

Elastography showed particularly high diagnostic accuracy in detecting severe fibrosis (F3) and cirrhosis (F4). Sensitivity and specificity rates increased with fibrosis progression. In early fibrosis stages, certain discrepancies between biopsy and elastography findings were observed.

Liver biopsy provided more detailed information regarding inflammatory infiltration, steatosis, necrosis, and architectural alterations. However, procedural discomfort and potential complications were noted in some patients.

Elastography demonstrated several advantages, including rapid examination time, non-invasive nature, repeatability, and patient safety. The method was especially useful for dynamic monitoring of fibrosis progression during treatment.

Discussion

The present study demonstrated that elastography is an effective and reliable non-invasive method for the assessment of liver fibrosis stages and shows a strong correlation with histopathological findings obtained through liver biopsy. The obtained results confirm the growing importance of elastographic techniques in modern hepatology and support their wider implementation in routine clinical practice.

Liver fibrosis is a dynamic pathological process that develops as a response to chronic liver injury caused by viral infections, metabolic disorders, alcohol abuse, autoimmune diseases, and toxic damage. Progressive accumulation of extracellular matrix proteins leads to architectural distortion of hepatic tissue and eventually cirrhosis. Therefore, early identification and continuous monitoring of fibrosis progression are essential for preventing irreversible complications and improving patient prognosis.

Traditionally, liver biopsy has been regarded as the gold standard for fibrosis assessment because it allows direct microscopic examination of liver tissue. Histological analysis provides detailed information not only about fibrosis stage but also about necroinflammatory activity, steatosis, bile duct pathology, vascular alterations, and cellular atypia. However, despite its diagnostic value, liver biopsy has several important limitations. The invasive nature of the procedure creates risks of pain, hemorrhage, infection, and accidental injury to adjacent organs. In addition, sampling error remains a significant problem because only a small fragment of liver tissue is evaluated, which may not accurately reflect the heterogeneous distribution of fibrosis throughout the liver.

The results of this study showed that elastography successfully overcomes many of these limitations. The method provides rapid, safe, painless, and repeatable assessment of liver stiffness without requiring tissue sampling. This is particularly important for patients who require repeated examinations during long-term follow-up and treatment monitoring. The ability to dynamically evaluate fibrosis progression represents one of the major clinical advantages of elastography over biopsy.

Our findings demonstrated that elastography possesses especially high diagnostic accuracy in advanced fibrosis and cirrhosis stages. Similar observations have been reported in numerous previous studies, which indicate that liver stiffness measurements strongly correlate with severe structural changes in hepatic tissue. In advanced disease, fibrotic tissue significantly increases liver stiffness, making elastographic measurements more reliable and reproducible.

However, certain limitations of elastography were also identified. In early fibrosis stages, differentiation between minimal and moderate fibrosis may be less accurate compared with histological examination. Furthermore, several clinical conditions may influence liver stiffness independently of fibrosis. Acute hepatic inflammation, cholestasis, venous congestion, obesity, and increased intra-abdominal pressure can artificially elevate stiffness measurements and potentially lead to overestimation of fibrosis severity. Technical difficulties may also occur in obese individuals or patients with narrow intercostal spaces.

Another important consideration is that elastography evaluates mechanical properties of liver tissue rather than direct histological changes. Consequently, elastography cannot provide detailed information regarding inflammatory infiltration, hepatocellular degeneration, steatosis, or microscopic vascular alterations. Therefore, in patients with uncertain diagnoses, autoimmune liver diseases, overlapping syndromes, or suspected malignancy, liver biopsy still retains considerable clinical importance.

The study findings suggest that elastography should not completely replace biopsy in all clinical situations. Instead, these methods should be viewed as complementary diagnostic tools. Elastography can serve as an effective first-line screening and monitoring method, while liver biopsy may be reserved for selected complex cases where detailed tissue analysis is required.

The growing use of elastography may also have important economic and organizational benefits. Reduced dependence on invasive procedures decreases hospitalization time, procedural complications, healthcare costs, and patient anxiety. Additionally, broader access to non-invasive fibrosis assessment may improve early diagnosis rates and facilitate timely therapeutic interventions.

Future research should focus on improving elastographic technologies, increasing diagnostic accuracy in early fibrosis stages, and combining elastography with serum biomarkers and artificial intelligence-based imaging analysis. Such integrated approaches may further enhance non-invasive liver fibrosis diagnostics and reduce the need for biopsy even more substantially.

Overall, the results of this study support the expanding role of elastography in the comprehensive evaluation of chronic liver diseases and highlight the importance of individualized diagnostic strategies based on clinical context and patient characteristics.

Conclusion

The assessment of liver fibrosis stage is a key component in the diagnosis, prognosis, and management of chronic liver diseases. Accurate determination of fibrosis severity allows clinicians to identify patients at risk of progression to cirrhosis, portal hypertension, liver failure, and hepatocellular carcinoma. Therefore, the choice of an appropriate diagnostic method has direct clinical importance.

The comparative analysis shows that elastography is a highly valuable non-invasive method for evaluating liver fibrosis. It is safe, painless, rapid, repeatable, and well accepted by patients. Elastography is especially effective in detecting advanced fibrosis and cirrhosis, where liver stiffness values strongly correlate with histological changes. Its repeatability makes it useful not only for initial diagnosis but also for long-term monitoring of disease progression and treatment response.

At the same time, liver biopsy remains an important diagnostic tool because it provides direct histological information about liver tissue. Unlike elastography, biopsy allows assessment of fibrosis, inflammatory activity, necrosis, steatosis, and other microscopic changes. This makes biopsy particularly useful in complex clinical cases, unclear diagnoses, autoimmune liver diseases, mixed liver pathology, or when non-invasive test results are contradictory.

However, the invasive nature of liver biopsy limits its routine and repeated use. Pain, bleeding risk, sampling error, and interobserver variability are important disadvantages. In contrast, elastography reduces the need for unnecessary biopsy procedures and improves patient comfort. Nevertheless, elastography results may be influenced by obesity, acute inflammation, cholestasis, hepatic congestion, and technical factors. For this reason, elastography should not be interpreted separately from clinical and laboratory data.

Thus, elastography can be recommended as a first-line method for screening, staging, and monitoring liver fibrosis in most patients with chronic liver disease. Liver biopsy should be reserved for selected cases where detailed histopathological confirmation is required. The most

effective diagnostic strategy is the combined use of elastography, biochemical markers, imaging methods, clinical assessment, and biopsy when indicated.

In conclusion, elastography and liver biopsy should not be considered completely competing methods, but rather complementary diagnostic tools. Their rational and individualized application can improve diagnostic accuracy, reduce procedural risks, support early treatment decisions, and improve the quality of care for patients with chronic liver diseases.

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