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Impact of Combined Ultrasonography and Magnetic Resonance Imaging in Diagnosis of Leg/Thigh Muscular Injuries in Hepatic Patients

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Abstract

Aim of the Study: To stand on the role of initial musculoskeletal ultrasonography of the leg & further scheduled MRI in the diagnosis & management of these variable muscle injuries and its impact on changing hepatic patients' clinical decision.

Methods: This is a case control study that was conducted on 30 patients attended to Hepatology/Gastroenterology & Radiology outpatient clinics at the National Liver Institute hospital for treatment of liver diseases and concomitant leg/thigh muscular injurious problems and 30 healthy controls with muscular lower limb injuries and free of hepatic diseases.

Results: Muscular injuries were detected in 57.1% [N = 20] of the participants, while 42.9% [N = 15] exhibited no evidence of muscular injury. Tendinous tear or avulsion was identified in 28.6% [N = 10] of cases, with 71.4% [N = 25] showing no such tendinous abnormalities. Cartilaginous injuries were observed in 14.3% [N = 5] of individuals, while 85.7% [N = 30] had no cartilaginous injuries.

Conclusion: Our study investigating the combined use of ultrasonography and MRI in hepatic patients with musculoskeletal injuries provides a nuanced understanding of the intricate relationships between liver diseases, associated conditions, and diagnostic modalities. Noteworthy associations between specific musculoskeletal findings and hepatic diagnoses reveal potential clinical implications, particularly in the context of liver cirrhosis.

Keywords: Ultrasonography; Magnetic Resonance Imaging; Muscular injuries; Hepatic patients.

INTRODUCTION

Imaging plays an essential role in the assessment of these complications and awareness of these musculoskeletal manifestations is vital for establishing a timely diagnosis and planning of appropriate therapy, as these disorders can significantly impact the morbidity and mortality and also influence candidacy for liver transplantation [1, 2].

Virtually, any system can be involved and in the past few decades, there has been major progress in the knowledge of multi-system effects of liver disease especially on the nervous and cardiopulmonary systems. However, very few reviews have studied the effects of chronic liver disease on the musculoskeletal system [3, 4].

Severe muscle wasting or sarcopenia is one of the most common, but frequently overlooked complications in patients with cirrhosis, which negatively impacts survival, quality of life and response to stresses, including infections and surgeries [5, 6].

Cirrhosis-related musculoskeletal disorders constitute a major cause of hospitalization for patients with chronic liver disease. While preventing these complications is challenging, their timely detection can help in the commencement of apposite therapy, thus helping curb the high morbidity and mortality associated with them [7, 8].

The association of muscle cramps with cirrhosis was first reported by Konikoff and Theodor in 1986 when they made their observation of repeated painful muscle cramps by patients with cirrhosis. They proposed that the strikingly high incidence and uniformity of the phenomenon may justify the inclusion of painful muscle cramps among the recognized symptoms of cirrhosis [9, 10].

Muscle cramps are highly prevalent in patients with cirrhosis, and their occurrence is associated with a significant decrease in health-related quality of life. There are no significant predictors for the occurrence of muscle cramps [11].

Compartment syndrome of the leg occurring in patients with coagulopathy secondary to cirrhosis is very difficult to manage. Coagulopathy in these patients is hard to correct and constant bleeding from fasciotomy site is a major complication mandating frequent transfusions of blood and blood products [12].

PATIENTS AND METHODS

Study Design and Setting: This is a case control hospital-based study which was conducted at the National Liver Institute, Menoufia Governorate during the duration of two years started at 2020 till 2022.

Study population: This study was conducted on 30 patients attended to Hepatology/Gastroenterology & Radiology outpatient clinics at the National Liver Institute hospital for treatment of liver diseases and concomitant leg/thigh muscular injurious problems and 30 healthy controls with muscular lower limb injuries and free of hepatic diseases.

Inclusion Criteria: Patients who were considered to be treated from any hepatic disease with associated leg/thigh muscle injuries, including [i.e. medial head of gastrocnemius, plantaris, politeus, rectus femoris or iliopsoas muscles]. Some patients with other tendinous or ligamentous injuries [e.g., Tendo-achilis or ilio-tibial band].

Exclusion Criteria: Patients with advanced blood or other systemic disease with evident diagnosis by laboratory results. Patients who received prior regional operative intervention or recent hemolytic drugs.

Study Tools: Patients were subjected to: Full history taking & complete clinical examination Laboratory investigations including liver function tests & complete blood picture & blood clotting profile: Liver function tests: Direct & Indirect Bilirubin levels - SGOT [serum glutamate oxaloacetate transaminase] -SGPT [serum glutamate pyruvate transaminase] -Alkaline phosphatase. Complete blood picture: It was essential for the exclusion of other causes of complicated muscular of ligamentous injuries including pyogenic abscesses or old liquefied or organized hematomas. Blood clotting profile: To indicate if underlying hepatic patient status implies on blood hemolysis or further systemic hemolytic disease or it is traumatic induced injury.

Child-Pugh grade & MELD: To stand on the hepatic patient status precisely & if compensated or decompensated.

Imaging Modalities:

Abdominal ultrasonography: To give definite picture of liver status [whether periportal fibrosis or cirrhosis], portal circulation [to assess portal hypertension or not], spleen volume & related dilated venous collaterals if any as well as presence of ascites or not.

Musclo-skeletal superficial ultrasonography: To assess the targeted soft tissue [muscular or ligamentous] injury on scanning of whole lower limb & guided by patient pain or complaint after trauma or not. Using linear high MHZ probe of US [8-15 MHZ] as applied on all our studies to trace the main injury then followed by MRI.

Magnetic resonance imaging [MRI]: It is the most definable radiological modality for soft tissue injuries as a whole specially after all types of traumas [whether sports, usual activity, stress injuries or road traffic ones]. In conjunction with patient complaint & linear superficial ultrasonography; it gives obvious details of site of injury, type of injury & grading of this soft tissue injury, then if hepatic disease induced or trauma or stress induced.

The sensitivity & specificity: Both linear superficial US & musculo-skeletal MRI were done as comparative study in between both modalities in exploring & defining the details of each hepatic patient soft tissue injury. However; MRI is still of high diagnostic accuracy as the last frame of radiological investigation that helping in predict the proper way to conclude this injury. US could be the 1st initial aid in assessment of these injuries specially if the patient is handicapped or comatosed.

Ethical considerations: Privacy and confidentiality of all patient's data were guaranteed and there has been a code number for every patient file that includes all investigations. All data provision were monitored and used for scientific purpose.

Data Analysis: Data were collected, tabulated and statistically analyzed using an IBM compatible personal computer with Statistical Package for the Social Sciences [SPSS] version 26 [SPSS Inc. Released 2018. IBM SPSS statistics for windows, version 26.0, Armnok, NY: IBM Corp.]. Significant test results were quoted as two-

tailed probabilities. Significance of the obtained results was judged at the 5.0% level [P > 0.05].

RESULTS

Clinicopathological Characteristics: The study encompassed a total of 35 hepatic patients, with a mean age of 44.77 years [± 18.40]. The majority of the participants were male, comprising 85.7% [N = 30], while the remaining 14.3% were female. They exhibited diverse liver disease severity with 62.9% classified as Child-Pugh Class A, 20.0% as Class B, and 17.1% as Class C. The mean Child-Pugh points were 6.37 [± 2.96], and the MELD score averaged 13.09 [± 5.70], with 28.6% [N = 10] categorized as Low risk, 54.3% [N = 19] as medium risk, and 17.1% [N = 6] as High risk. Key laboratory parameters revealed mean values for bilirubin [2.22 mg/dl ± 0.80], ALT [60.71 IU/L ± 16.32], AST [55.63 IU/L ± 14.98], HB [11.26 g/dl ± 1.44], PT [13.23 seconds ± 3.34], PTT [44.29 seconds ± 9.22], INR [1.27 ± 0.33], and creatinine [1.20 ± 0.22] [Table 1].

Abdominal Ultrasound Findings: It revealed critical insights into hepatic and associated conditions. Fatty Bright hepatomegaly was observed in 48.6% [N = 17] of the patients, while 51.4% [N = 18] had no evidence of this condition. Liver cirrhosis was diagnosed in 34.3% [N = 12] of participants, with the majority, 65.7% [N = 23], exhibiting no signs of cirrhosis. Portal hypertension was present in 25.7% [N = 9] of the patients, while 74.3% [N = 26] had no indications of portal hypertension. Splenomegaly was noted in 28.6% [N = 10] of cases, and 71.4% [N = 25] had no splenomegaly. Ascites, a common hepatic complication, was observed in 37.1% [N = 13] of patients, while 62.9% [N = 22] had no ascites.

Superficial Ultrasound Findings: It provided crucial insights into musculo-skeletal conditions among hepatic patients. Muscular injury was identified in 57.1% [N = 20] of the participants, while 42.9% [N = 15] exhibited no evidence of muscular injury. Tendinous tear or avulsion was observed in 28.6% [N = 10] of cases, with 71.4% [N = 25] showing no such tendinous abnormalities. Cartilaginous injuries were detected in 14.3% [N = 5] of individuals, while 85.7% [N = 30] had no cartilaginous injuries. Soft tissue hematomas were prevalent in 60.0% [N = 21] of patients, while 40.0% [N = 14] had no hematomas. Ultrasound examinations also revealed bursitis, synovial plicae, or edema in 54.3% [N = 19] of cases, and 45.7% [N = 16] exhibited no such soft tissue conditions. Peri fracture soft tissue injuries were noted in 14.3% [N = 5] of participants, while 85.7% [N = 30] showed no peri fracture injuries. Ligamentous injuries were identified in 34.3% [N = 12] of patients, with 65.7% [N = 23] displaying no ligamentous abnormalities. Moreover, muscle mass lesions were observed in 11.4% [N = 4] of cases, while 88.6% [N = 31] exhibited no muscle mass lesions.

Association between diagnosis and MRI signs: It revealed intriguing connections. Muscular injuries were notably more prevalent in patients with liver cirrhosis, affecting 55.0% [N = 11], while a smaller percentage of patients with NAFLD [15.0%, N = 3] and NASH [20.0%, N = 4] exhibited these injuries. In contrast, viral hepatitis was associated with muscular injuries in only 10.0% [N = 2] of cases. Tendinous tear or avulsion did not show significant associations with any of the diagnoses. Cartilaginous injuries, on the other hand, were more common in patients with NAFLD [60.0%, N = 3] and NASH [20.0%, N = 1], and soft tissue hematomas were more prevalent in patients with liver cirrhosis [47.6%, N = 10]. Bursitis or synovial plicae or edema exhibited no significant diagnostic associations. However, peri fracture soft tissue injuries were more frequent in patients with viral hepatitis [40.0%, N = 2]. Ligamentous injuries were more common in patients with liver cirrhosis [34.8%, N = 8] and those with NAFLD [50.0%, N = 6]. Furthermore, muscle mass lesions were more frequent in patients with NASH [50.0%, N = 2]. The calculated P-values indicated a significant association between liver cirrhosis and muscular injuries [p = 0.009], as well as potential trends in other Musculo-skeletal findings across different hepatic diagnoses [Table 3].

MRI Signs: It provided valuable insights into Musculo-skeletal conditions within the hepatic patient cohort. Muscular injuries were detected in 57.1% [N = 20] of the participants, while 42.9% [N = 15] exhibited no evidence of muscular injury. Tendinous tear or avulsion was identified in 28.6% [N = 10] of cases, with 71.4% [N = 25] showing no such tendinous abnormalities. Cartilaginous injuries were observed in 14.3% [N = 5] of individuals, while 85.7% [N = 30] had no cartilaginous injuries. Soft tissue hematomas were prevalent in 60.0% [N = 21] of patients, while 40.0% [N = 14] had no hematomas. Additionally, MRI examinations revealed bursitis, synovial plicae, or edema in 54.3% [N = 19] of cases, with 45.7% [N = 16] showing no such soft tissue conditions. Peri fracture soft tissue injuries were noted in 14.3% [N = 5] of participants, while 85.7% [N = 30] had no peri fracture injuries. Ligamentous injuries were identified in 34.3% [N = 12] of patients, and 65.7% [N = 23] exhibited no ligamentous abnormalities. Furthermore, muscle mass lesions were observed in 11.4% [N = 4] of cases, while 88.6% [N = 31] exhibited no muscle mass lesions.

Association between diagnosis and superficial ultrasound findings: It revealed noteworthy correlations. Among patients with Non-Alcoholic Fatty Liver Disease [NAFLD], 15.0% [N = 3] exhibited muscular injuries, while 53.3% [N = 8] did not. In contrast, 20.0% [N = 4] of those with Non-Alcoholic Steato-Hepatitis [NASH] had muscular injuries, with 13.3% [N = 2] showing no injuries. Liver cirrhosis was strongly associated with muscular injuries, affecting 55.0% [N = 11] of patients with cirrhosis compared to 6.7% [N = 1] without. Likewise, viral hepatitis was linked to muscular injuries, impacting 10.0% [N = 2] with hepatitis, while 26.7% [N = 4] had no muscular injuries. P-values, which assess the significance of these associations, were calculated, revealing a significant correlation for liver cirrhosis [p = 0.009] and no significant associations for other ultrasound findings [Table 2].

CASES

Case [1]: A male patient 39 years old has a clinical history of non-alcoholic steatohepatitis 'NASH'. He has fatty liver changes on abdominal ultrasonography scan. He developed soft tissue muscular injury within deep strips of left gluteus maximus muscle. It appears as high signal T2 strips of linear injury on MRI images, while edematous hypoechoic on superficial ultrasound scan on same anatomical plane with evident tenderness on probing **[Figure 1].**

Case [2]: A young male patient of viral hepatitis B has 20 years old has enlarged edematous bright liver parenchyma & few small GB stones. However; incidentally noted or under limited stress trauma developed a localized pre-tibial swelling for 4 days. It seems as ovoid hypoechoic lesion on ultrasound scanning with profuse surrounding hyperechoic inflammatory fatty adipose soft tissue planes. However; MRI shows variable layering high signal pattern of this hematoma with concentric pattern on all available T2 WI series with profuse surrounding adipose soft tissue edematous changes **[Figure 2].**

Table [1]: Clinical and Laboratory findings among study population

Variable		Value
Child-Pugh grade	class A [n, %] class B [n, %] class C [n, %] Points [Mean ± SD]	22 [62.9%] 7 [20.0%] 6 [17.1%] 6.37 ± 2.96
MELD score	[Mean ± SD] Low = 2-6% medium = 6-19% High = 20-52%	13.09 ± 5.70 10 [28.6%] 19 [54.3%] 6 [17.1%]
Bilirubin[mg/dl] [Mean ± SD]		2.22 ± 0.80
ALT [IU/L] [Mean ± SD]		60.71 ± 16.32
AST [IU/L] [Mean ± SD]		55.63 ± 14.98
HB [Mean ± SD]		11.26 ± 1.44
PT [sec] [Mean ± SD]		13.23 ± 3.34
PTT [sec] [Mean ± SD]		44.29 ± 9.22
INR [Mean ± SD]		1.27 ± 0.33
Creatinine [Mean ± SD]		1.20 ± 0.22

Table [2]: Association between diagnosis and superficial ultrasound findings

		Diagnosis				P-value
		NAFLD	NASH	Liver cirrhosis	Viral Hepatitis	
Muscular injury [n, %]	yes no	3 [15.0%] 8 [53.3%]	4 [20.0%] 2 [13.3%]	11 [55.0%] 1 [6.7%]	2 [10.0%] 4 [26.7%]	0.009
Tendinous tear or avulsion [n, %]	yes no	5 [50.0%] 6 [24.0%]	1 [10.0%] 5 [20.0%]	3 [30.0%] 9 [36.0%]	1 [10.0%] 5 [20.0%]	0.485
Cartilaginous injury [n, %]	yes no	3 [60.0%] 8 [26.7%]	0 [0.0%] 6 [20.0%]	1 [20.0%] 11 [36.7%]	1 [20.0%] 5 [16.7%]	0.409
Soft tissue hematoma [n, %]	yes no	5 [23.8%] 6 [42.9%]	4 [19.0%] 2 [14.3%]	10 [47.6%] 2 [14.3%]	2 [9.5%] 4 [28.6%]	0.134
Bursitis or synovial plicae or edema [n, %]	yes no	7 [36.8%] 4 [25.0%]	1 [5.3%] 5 [31.3%]	7 [36.8%] 5 [31.3%]	4 [21.1%] 2 [12.5%]	0.235
Peri fracture soft tissue injury [n, %]	yes no	1 [20.0%] 10 [20.0%]	1 [20.0%] 5 [16.7%]	1 [20.0%] 11 [36.7%]	2 [40.0%] 4 [13.3%]	0.495
Ligamentous injury [n, %]	yes no	6 [50.0%] 5 [21.7%]	1 [8.3%] 5 [21.7%]	4 [33.3%] 8 [34.8%]	1 [8.3%] 5 [21.7%]	0.300
Muscle mass lesion [n, %]	yes no	0 [0.0%] 11 [35.5%]	2 [50.0%] 4 [12.9%]	1 [25.0%] 11 [35.5%]	1 [25.0%] 5 [16.1%]	0.209

Table [3]: Association between diagnosis and MRI signs

		Diagnosis				P-value
		NAFLD	NASH	Liver cirrhosis	Viral Hepatitis	
Muscular injury [n, %]	yes no	3 [15.0%] 8 [53.3%]	4 [20.0%] 2 [13.3%]	11 [55.0%] 1 [6.7%]	2 [10.0%] 4 [26.7%]	0.009
Tendinous tear or avulsion [n, %]	yes no	5 [50.0%] 6 [24.0%]	1 [10.0%] 5 [20.0%]	3 [30.0%] 9 [36.0%]	1 [10.0%] 5 [20.0%]	0.485
Cartilaginous injury [n, %]	yes no	3 [60.0%] 8 [26.7%]	0 [0.0%] 6 [20.0%]	1 [20.0%] 11 [36.7%]	1 [20.0%] 5 [16.7%]	0.409
Soft tissue hematoma [n, %]	yes no	5 [23.8%] 6 [42.9%]	4 [19.0%] 2 [14.3%]	10 [47.6%] 2 [14.3%]	2 [9.5%] 4 [28.6%]	0.134
Bursitis or synovial plicae or edema [n, %]	yes no	7 [36.8%] 4 [25.0%]	1 [5.3%] 5 [31.3%]	7 [36.8%] 5 [31.3%]	4 [21.1%] 2 [12.5%]	0.235
Peri fracture soft tissue injury [n, %]	yes no	1 [20.0%] 10 [20.0%]	1 [20.0%] 5 [16.7%]	1 [20.0%] 11 [36.7%]	2 [40.0%] 4 [13.3%]	0.495
Ligamentous injury [n, %]	yes no	6 [50.0%] 5 [21.7%]	1 [8.3%] 5 [21.7%]	4 [33.3%] 8 [34.8%]	1 [8.3%] 5 [21.7%]	0.300
Muscle mass lesion [n, %]	yes no	0 [0.0%] 11 [35.5%]	2 [50.0%] 4 [12.9%]	1 [25.0%] 11 [35.5%]	1 [25.0%] 5 [16.1%]	0.209

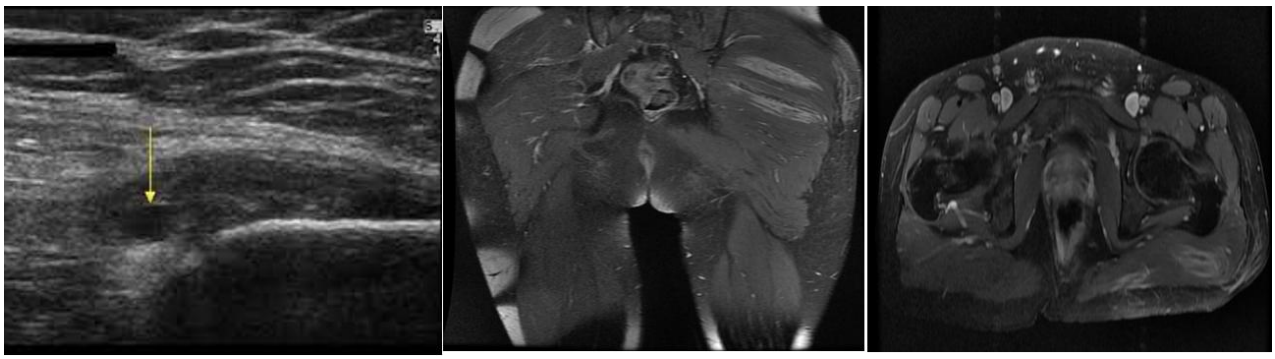

Figure [1]: Showing high signal T2 strips of linear injury on MRI images, while edematous hypoechoic on superficial ultrasound scan on same anatomical plane with evident tenderness on probing.

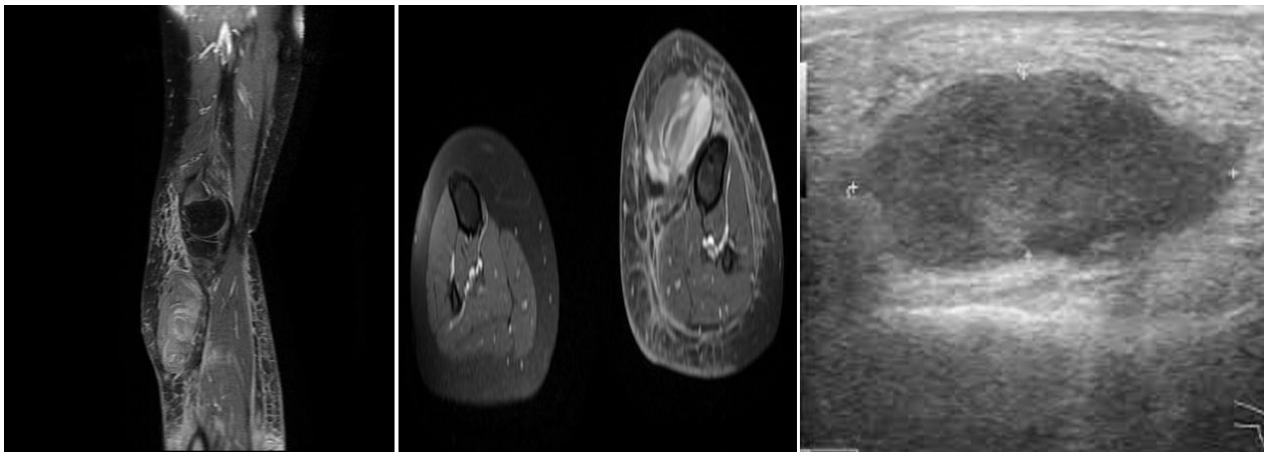

Figure [2]: Showing an ovoid hypoechoic lesion on ultrasound scanning with profuse surrounding hyperechoic inflammatory fatty adipose soft tissue planes. MRI shows variable layering high signal pattern of this hematoma with concentric pattern on all available T2 WI series with profuse surrounding adipose soft tissue edematous changes.

DISCUSSION

The findings of this study, exploring the utility of combined ultrasonography and MRI in diagnosing of musculo-skeletal injuries in hepatic patients, contribute valuable insights to the existing body of literature. Comparable studies investigating musculo-skeletal conditions in liver disease patients are limited, making this research particularly significant [13].

Our study revealed a high prevalence of musculo-skeletal abnormalities, such as muscular injuries, tendinous tear or avulsion, and ligamentous injuries, in hepatic patients, especially those with liver cirrhosis. These results align with the work of **Hari *et al.*** who found an increased incidence of musculo-skeletal disorders in cirrhotic patients, attributing it to the complex interplay between liver dysfunction and altered musculo-skeletal physiology [14].

The comprehensive evaluation of laboratory, abdominal ultrasound, and superficial ultrasound findings in our study, focusing on hepatic patients with leg/thigh muscular injuries, offers valuable insights into the intricate interplay between liver disease and musculoskeletal health [15, 16].

The diverse liver disease severity in our cohort, as indicated by Child-Pugh classification and MELD scores, aligns with previous research highlighting the multifaceted impact of hepatic conditions on various physiological parameters. Notably, the prevalence of MRI musculoskeletal abnormalities in our study, such as muscular injuries [57.1%], tendinous tears or avulsions [28.6%], and ligamentous injuries [34.3%], underscores the heightened vulnerability of hepatic patients to such complications, aligning with studies by **Ranjan *et al.*** which emphasize the increased susceptibility of individuals with liver disease to musculoskeletal trauma and bleeding events [17, 18].

Additionally, our findings on soft tissue hematomas [60.0%] and cartilaginous injuries [14.3%] contribute to the growing body of evidence suggesting an increased susceptibility to bleeding events and joint-related abnormalities in hepatic patients, as documented by **Ferreira *et al.*** [9]

Conclusion:

Our study investigating the combined use of ultrasonography and MRI in hepatic patients with musculoskeletal injuries provides a nuanced understanding of the intricate relationships between liver diseases, associated conditions, and diagnostic modalities. The diverse demographic characteristics and varied liver disease severity within the study cohort underscore the complex clinical landscape in this population. Noteworthy associations between specific musculo-skeletal findings and hepatic diagnoses reveal potential clinical implications, particularly in the context of liver cirrhosis. Furthermore, the comprehensive examination of laboratory parameters highlights the systemic impact of liver diseases on biochemical markers. These findings collectively emphasize the importance of tailored diagnostic approaches and underline the need for further research to refine clinical strategies for hepatic patients with musculoskeletal injuries.

Recommendations:

Integrated Imaging Approach: Employ a combined ultrasonography and MRI strategy for efficient and detailed diagnosis of musculoskeletal issues in hepatic patients. Targeted Monitoring for Cirrhosis: Implement regular musculoskeletal assessments, especially for cirrhotic patients, to detect and manage injuries promptly. Multidisciplinary Collaboration: Foster collaboration among hepatologists, radiologists, and orthopedic specialists for a comprehensive understanding and management of musculoskeletal complications in hepatic conditions. Longitudinal Studies and Guidelines: Prioritize longitudinal studies and develop guidelines for the standardized management of musculoskeletal problems in hepatic patients.

Ethics approval and consent to participate:

Our local Ethics Committee approved our study and a written consent for participation was obtained from all patients.

Authors' contributions:

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Disclosure:

The authors declare no competing interests in this work.

Conflicts of interest and source of funding:

No conflicts of Interest or funding source to declare.

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