



## Original Research Article

# TO COMPARE THE USG GUIDED THIGH MUSCLE MASS AND HAND GRIP STRENGTH IN CHRONIC LIVER DISEASE PATIENT

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## ABSTRACT

The Consumer Protection Act (CPA), enacted in 1986 and amended in 2019, significantly reshaped the medico-legal environment in India by formally bringing healthcare services within its purview. This has led to a paradigm shift in the doctor-patient relationship, emphasizing patient rights, accountability, and the legal responsibility of healthcare providers. The objective is to review and interpret existing literature on the application and impact of the Consumer Protection Act in Indian medical practice, with particular attention to litigation trends, key legal judgments, documentation practices, and the implications of the 2019 amendment.

Sarcopenia is a common and clinically important complication of chronic liver disease (CLD), associated with poor functional capacity, hepatic decompensation, and adverse outcomes. This hospital-based observational study was conducted in the Department of General Medicine, Shyam Shah Medical College and associated hospitals over one year and included 100 patients with CLD. Demographic characteristics, etiology, biochemical parameters, Child-Pugh class, and MELD-Na scores were recorded. Muscle strength was assessed using hand grip strength (HGS) measured by a dynamometer, while muscle mass was evaluated by ultrasonography-guided thigh muscle thickness (TMT). The majority of patients were males (68%), with most belonging to the 41–60 years age group, and alcoholic liver disease was the most common etiology (40%). Reduced HGS and TMT were observed in 58% and 54% of patients, respectively, while sarcopenia was present in 52% of cases. A strong positive correlation was found between HGS and TMT ( $r = +0.68$ ,  $p < 0.001$ ), and both parameters showed a significant decline with increasing Child-Pugh class ( $p < 0.001$ ). Sarcopenia was significantly associated with hepatic decompensation events, including ascites, hepatic encephalopathy, variceal bleeding, and jaundice. HGS  $< 22$  kg demonstrated a sensitivity of 78.8% and specificity of 75.0%, whereas TMT  $< 34$  mm showed a sensitivity of 76.9% and specificity of 72.9% for predicting sarcopenia. These findings indicate that USG-guided thigh muscle thickness and hand grip strength are simple, non-invasive, reliable, and cost-effective tools for the assessment of sarcopenia in CLD patients, with significant correlations to disease severity and decompensation, making them valuable for early identification of high-risk patients and prognostic evaluation.

**Keywords:** Chronic liver disease, Sarcopenia, Hand grip strength, Thigh muscle thickness, Ultrasonography, Child-Pugh class, MELD-Na score, Muscle wasting.

## INTRODUCTION

Chronic liver disease (CLD) is a major cause of morbidity and mortality worldwide and represents a significant healthcare burden. It is characterized by progressive destruction and regeneration of liver parenchyma leading to fibrosis, cirrhosis, and eventually liver failure.<sup>[1]</sup> Common etiologies include alcohol-related liver disease, chronic viral hepatitis, autoimmune liver disorders, and metabolic dysfunction-associated steatotic liver disease (MASLD). As liver disease progresses, patients develop complications such as portal hypertension, ascites, spontaneous bacterial peritonitis, variceal hemorrhage, hepatic encephalopathy, and hepatocellular carcinoma, all of which contribute substantially to poor quality of life and increased mortality.<sup>[3]</sup>

In recent years, sarcopenia has emerged as an important extrahepatic manifestation of chronic liver disease. Sarcopenia is defined as a progressive and generalized loss of skeletal muscle mass, muscle strength, and physical performance. It is increasingly recognized as an independent predictor of adverse outcomes in CLD patients, including prolonged hospitalization, increased susceptibility to infections, poor response to treatment, higher risk of hepatic decompensation, and reduced survival.<sup>3</sup> The prevalence of sarcopenia among patients with liver cirrhosis varies widely, ranging from 30% to 70%, depending on the severity of liver dysfunction and the diagnostic criteria used.<sup>[4]</sup>

The development of sarcopenia in CLD is multifactorial. Chronic liver dysfunction results in alterations in protein, carbohydrate, and lipid metabolism, leading to increased protein catabolism and decreased protein synthesis. Additional contributing factors include reduced dietary intake due to anorexia, nausea, early satiety from ascites, malabsorption, hormonal disturbances, chronic systemic inflammation, hyperammonemia, and decreased physical activity. Recurrent episodes of hepatic decompensation and prolonged hospital stays further accelerate muscle wasting. Consequently, loss of skeletal muscle mass and strength has become an important indicator of nutritional status and disease progression in patients with chronic liver disease.<sup>[5]</sup>

Assessment of sarcopenia requires evaluation of both muscle mass and muscle strength. Hand grip strength (HGS) has gained widespread acceptance as a simple, inexpensive, and reliable measure of muscle strength and functional capacity. It can be performed easily at the bedside using a handheld dynamometer and has shown significant correlation with frailty, nutritional status, and clinical outcomes in patients with chronic liver disease. Several studies have demonstrated that reduced hand grip strength is associated with increased risk of complications, poor quality of life, and higher mortality among cirrhotic patients.<sup>[6]</sup>

Assessment of muscle mass traditionally relies on imaging modalities such as computed tomography (CT), magnetic resonance imaging (MRI), and dual-energy X-ray absorptiometry (DEXA). However, these techniques are expensive, less accessible, and may not be suitable for routine clinical use. Ultrasonography (USG)-guided measurement of thigh muscle thickness (TMT) has emerged as a practical alternative for evaluating skeletal muscle mass.<sup>[7]</sup> Ultrasonography is non-invasive, radiation-free, readily available, cost-effective, and can be repeated frequently. Measurement of thigh muscle thickness provides an objective assessment of peripheral muscle mass and has shown promising utility in identifying sarcopenia and monitoring nutritional status in various chronic diseases, including liver disease.<sup>[8]</sup>

Despite the growing recognition of sarcopenia as an important prognostic factor in chronic liver disease, comparative studies evaluating the relationship between muscle mass measured by USG-guided thigh muscle thickness and muscle strength assessed by hand grip strength remain limited, particularly in resource-constrained settings. Establishing the correlation between these two simple bedside tools may facilitate early diagnosis of sarcopenia and improve risk stratification in CLD patients.<sup>[9]</sup>

Therefore, the present study was undertaken in the Department of General Medicine, Shyam Shah Medical College and Associated Hospitals, Rewa, to evaluate the correlation between USG-guided thigh muscle mass and hand grip strength in patients with chronic liver disease, assess the prevalence of sarcopenia, and study their prognostic implications in relation to disease severity.

## MATERIALS AND METHODS

**Study Design and Setting:** This hospital-based cross-sectional observational study was conducted over a period of one year in the Department of General Medicine, Shyam Shah Medical College and Associated Hospitals, Rewa, Madhya Pradesh.

**Study Population:** A total of 100 patients aged  $\geq 18$  years with clinically, biochemically, and radiologically confirmed chronic liver disease (CLD) were included after obtaining informed written consent. Patients with acute liver failure, hepatocellular carcinoma, severe ascites interfering with ultrasonographic assessment, neuromuscular disorders, upper limb deformities, or critical illness were excluded.

**Clinical Assessment:** Detailed demographic and clinical data were recorded. Disease severity was assessed using the Child–Turcotte–Pugh (CTP) classification based on serum bilirubin, serum albumin, INR, ascites, and hepatic encephalopathy.

**Hand Grip Strength Measurement:** Hand grip strength (HGS) was measured using a calibrated hand-held dynamometer. Three readings were obtained from the dominant hand with the patient

seated and the elbow flexed at 90°, and the highest value was recorded in kilograms (kg).

**Ultrasonographic Assessment of Thigh Muscle Mass:** Thigh muscle thickness was measured using a high-resolution ultrasound machine with a 7–12 MHz linear probe. Measurements were taken at the midpoint between the anterior superior iliac spine and the superior border of the patella on the dominant leg. The average of three readings was considered for analysis.

**Assessment of Sarcopenia:** Sarcopenia was assessed using both hand grip strength and ultrasonography-guided thigh muscle thickness. Patients with reduced muscle strength and muscle mass were classified as sarcopenic.

**Statistical Analysis:** Data were entered into Microsoft Excel and analyzed using SPSS software. Continuous variables were expressed as mean  $\pm$  standard deviation, while categorical variables were presented as frequencies and percentages. Student's t-test, one-way ANOVA, Chi-square test, and Pearson's correlation coefficient were used as appropriate. A p-value  $<0.05$  was considered statistically significant.

**Ethical Considerations:** The study was approved by the Institutional Ethics Committee, and written informed consent was obtained from all participants before enrollment. Confidentiality of patient information was maintained throughout the study.

## RESULTS

Among the 100 patients studied, the largest proportion belonged to the 41–50 years age group (26%), followed by 51–60 years (24%), indicating that chronic liver disease predominantly affected middle-aged individuals. Male patients constituted 68% of the study population, demonstrating a clear male predominance. Regarding etiology, alcohol-related liver disease was the most common cause of CLD (40%), followed by viral hepatitis (30%) and metabolic dysfunction-associated steatotic liver disease (MASLD) (20%). These findings suggest that alcohol consumption remains a major contributor to chronic liver disease in the study population.

**Table 1: Disease Severity and Sarcopenia Profile among CLD Patients**

| Parameter                  | Category  | Number (n) | Percentage (%) |
|----------------------------|-----------|------------|----------------|
| Child-Pugh Class           | A         | 30         | 30.0           |
|                            | B         | 40         | 40.0           |
|                            | C         | 30         | 30.0           |
| MELD-Na Score              | $<10$     | 18         | 18.0           |
|                            | 10–19     | 42         | 42.0           |
|                            | 20–29     | 28         | 28.0           |
|                            | $\geq 30$ | 12         | 12.0           |
| Low Hand Grip Strength     | Present   | 58         | 58.0           |
| Low Thigh Muscle Thickness | Present   | 54         | 54.0           |
| Sarcopenia                 | Present   | 52         | 52.0           |

Assessment of disease severity revealed that the majority of patients belonged to Child-Pugh Class B (40%), while Classes A and C each comprised 30% of cases. Most patients had MELD-Na scores between 10 and 19 (42%), indicating moderate disease severity. Low hand grip strength was

observed in 58% of patients, whereas reduced thigh muscle thickness was found in 54%. Overall, sarcopenia was present in 52% of the study population. These findings demonstrate a substantial burden of muscle wasting and impaired muscle function among patients with chronic liver disease.

**Table 2: Comparison of Hand Grip Strength and Thigh Muscle Thickness According to Gender**

| Parameter                   | Category       | Number (n)     | Percentage (%) |
|-----------------------------|----------------|----------------|----------------|
| Hand Grip Strength (kg)     | $24.8 \pm 6.2$ | $16.5 \pm 4.8$ | $<0.001$       |
| Thigh Muscle Thickness (mm) | $37.9 \pm 6.5$ | $34.8 \pm 6.1$ | 0.020          |

Male patients demonstrated significantly higher muscle strength and muscle mass compared with female patients. The mean hand grip strength among males was  $24.8 \pm 6.2$  kg compared to  $16.5 \pm 4.8$  kg among females, and this difference was highly significant ( $p < 0.001$ ). Similarly, mean thigh

muscle thickness was significantly greater in males ( $37.9 \pm 6.5$  mm) than in females ( $34.8 \pm 6.1$  mm) ( $p = 0.020$ ). These findings reflect the expected physiological differences in skeletal muscle mass and strength between genders.

**Table 3: Association of Hand Grip Strength, Thigh Muscle Thickness and Sarcopenia with Child-Pugh Class**

| Parameter              | Category       | Number (n)     | Percentage (%) | Parameter |
|------------------------|----------------|----------------|----------------|-----------|
| Mean HGS (kg)          | $28.2 \pm 5.1$ | $23.5 \pm 4.8$ | $19.1 \pm 5.3$ | $<0.001$  |
| Mean TMT (mm)          | $41.2 \pm 5.2$ | $36.5 \pm 5.7$ | $31.4 \pm 6.0$ | $<0.001$  |
| Sarcopenia Present (n) | 8              | 20             | 24             | $<0.001$  |

A significant decline in both hand grip strength and thigh muscle thickness was observed with increasing severity of liver disease. Patients in Child-Pugh Class A exhibited the highest mean hand grip strength ( $28.2 \pm 5.1$  kg) and thigh muscle thickness ( $41.2 \pm 5.2$  mm), while those in Child-Pugh Class C had the lowest values ( $19.1 \pm 5.3$  kg

and  $31.4 \pm 6.0$  mm, respectively). Furthermore, the prevalence of sarcopenia increased progressively with worsening Child-Pugh class, from 8 cases in Class A to 24 cases in Class C. These findings indicate a strong association between progressive hepatic dysfunction and deterioration of skeletal muscle mass and strength.

**Table 4: Correlation between Hand Grip Strength and Thigh Muscle Thickness**

| Variable | Correlation Coefficient (r) | p-value |
|----------|-----------------------------|---------|
| HGSvsTMT | +0.68                       | <0.001  |

Pearson's correlation analysis demonstrated a strong positive correlation between hand grip strength and thigh muscle thickness ( $r = +0.68$ ,  $p < 0.001$ ). This indicates that patients with greater muscle mass tended to have better muscle strength, whereas

reduced thigh muscle thickness was associated with diminished hand grip strength. The significant correlation supports the validity of both parameters as complementary measures for assessing sarcopenia in chronic liver disease.

**Table 5: Diagnostic Performance of Hand Grip Strength and Thigh Muscle Thickness for Predicting Sarcopenia**

| Parameter              | Cut-off Value<br>Sensitivity (%)<br>Specificity (%)<br>p-value | Parameter | Cut-off Value<br>Sensitivity (%)<br>Specificity (%)<br>p-value | Parameter |
|------------------------|----------------------------------------------------------------|-----------|----------------------------------------------------------------|-----------|
| Hand Grip Strength     | <22 kg                                                         | 78.8      | 75.0                                                           | <0.001    |
| Thigh Muscle Thickness | <34 mm                                                         | 76.9      | 72.9                                                           | <0.001    |

Hand grip strength and ultrasonography-guided thigh muscle thickness demonstrated good diagnostic performance for identifying sarcopenia. A hand grip strength cut-off value of <22 kg showed a sensitivity of 78.8% and specificity of 75.0%, whereas a thigh muscle thickness cut-off value of <34 mm demonstrated a sensitivity of 76.9% and specificity of 72.9%. Both parameters were statistically significant predictors of sarcopenia ( $p < 0.001$ ). These results suggest that HGS and TMT are reliable, simple, and non-invasive tools for screening and evaluating sarcopenia in patients with chronic liver disease.

## DISCUSSION

Chronic liver disease (CLD) is frequently associated with sarcopenia, which adversely affects functional status, quality of life, and survival. In the present study, conducted among 100 CLD patients, a high prevalence of sarcopenia was observed, and both hand grip strength (HGS) and ultrasonography-guided thigh muscle thickness (TMT) showed significant associations with disease severity.<sup>[10-18]</sup> Most patients belonged to the middle-aged age group, particularly 41–50 years (26%) and 51–60 years (24%). Similar observations were reported by Mehta SK et al. (2023), Suresh A et al. (2023), and Mukherjee et al. (2017). Male predominance (68%) in our study was also comparable to findings by Mehta SK et al. (2023) and Sagnelli E et al. (2018). Alcohol-related liver disease was the commonest etiology (40%), followed by viral hepatitis (30%) and MASLD (20%), which is consistent with reports by Swaroop S et al. (2023) and Mukherjee et al. (2017).<sup>[19-30]</sup>

Biochemical abnormalities such as anemia, thrombocytopenia, renal dysfunction, and vitamin deficiencies were common. Reduced hemoglobin levels were comparable to findings by Joshi D et al. (2023) and Ware S et al. (2022), while thrombocytopenia was similar to observations by Dr. Manjeet Singh et al. (2025). Vitamin D deficiency noted in our patients agrees with studies by Narayanasamy K et al. (2019), Khan MA et al. (2019), Zafar Abdul Nabi et al. (2024), and Jamil Z et al. (2018), highlighting its contribution to muscle weakness and sarcopenia.<sup>[31-37]</sup>

Assessment of disease severity revealed that 70% of patients belonged to Child–Pugh Classes B and C, indicating advanced liver dysfunction. Similar findings were reported by Suresh A et al. (2023), while Mehta SK et al. (2023) observed a greater proportion of Child–Pugh A patients. Comparable MELD–Na score distributions were reported by Al-Dholae MHH (2023), Goudsmith BF et al. (2022), and Kim JW et al. (2023).<sup>[38-43]</sup>

Muscle strength and muscle mass were significantly reduced in CLD patients. Mean HGS was lower in females than males, similar to observations by Nishikawa H et al. (2018, 2019) and Yoh K et al. (2020). Mean TMT was also lower among females and comparable to ultrasound-based findings by Hida T et al. (2018). Reduced HGS (58%) and TMT (54%) reflected a substantial burden of sarcopenia, supporting findings by Rajendiran et al. (2024) and Rao NS et al. (2022).<sup>[44-47]</sup>

The overall prevalence of sarcopenia was 52%, which is comparable to reports by Chennapareddy VKR et al. (2026), Mazeaud S et al. (2023), and He S et al. (2025). Both HGS and TMT declined significantly with increasing Child–Pugh class, and sarcopenia became more frequent in advanced liver

disease. Similar associations were reported by Sundar S et al. (2025), John II et al. (2025), Ciocîrlan M et al. (2017), Saeidi R et al. (2026), and Majeed T et al. (2024).<sup>[48-53]</sup>

Sarcopenic patients had significantly lower HGS and TMT values and experienced more hepatic decompensation events, including ascites, encephalopathy, variceal bleeding, and jaundice. These findings are consistent with studies by Xiao L et al. (2023), Salama MM et al. (2023), Hida T et al. (2018), Tandon P et al. (2021), Thyloor Kenchappa S et al. (2023), and Tuo S et al. (2024), emphasizing the prognostic importance of sarcopenia in CLD.

Diagnostic analysis showed that both HGS and TMT were effective tools for detecting sarcopenia, with HGS demonstrating slightly better performance. Similar diagnostic utility of ultrasound-based muscle assessment has been reported by Hida T et al. (2018), Rao NS et al. (2022), and Yang S et al. (2025).

Overall, the present study demonstrates that sarcopenia is highly prevalent in chronic liver disease and is strongly associated with disease severity and hepatic decompensation. Hand grip strength and ultrasonography-guided thigh muscle thickness are simple, reliable, and non-invasive bedside tools that can aid in early identification, risk stratification, and management of CLD patients.

## CONCLUSION

The present study demonstrated a high prevalence of sarcopenia among patients with chronic liver disease, with a significant association with disease severity and hepatic decompensation. Both hand grip strength (HGS) and ultrasonography-guided thigh muscle thickness (TMT) declined progressively with worsening Child–Pugh class and MELD-Na scores. Sarcopenic patients had lower muscle strength and muscle mass and experienced more complications. HGS showed slightly better diagnostic performance, although both HGS and TMT were reliable, non-invasive, and cost-effective tools. Routine assessment of these parameters may facilitate early detection of sarcopenia and improve clinical outcomes in CLD patients.

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