Journal of Frailty, Sarcopenia and Falls

Original Article

Validation of a Low-Cost Handheld Dynamometer Against a Standard Device for Handgrip Strength Assessment in Stable Outpatients with Cirrhosis

Shardhya Chakraborty#1, Akash Roy#2, Surender Singh[3], Moumita Sharma[1], Awanish Tewari[2], Nikhil Sonthalia[2], Uday Chand Ghoshal[1], Mahesh K. Goenka[2]

[1]Division of Dietetics, Institute of Gastrosciences and Liver Transplantation, Apollo Multispeciality Hospitals, Kolkata, India;
[2]Department of Gastroenterology, Institute of Gastrosciences and Liver Transplantation, Apollo Multispeciality Hospitals, Kolkata, India;
[3]Department of Hepatology, Sanjay Gandhi Post Graduate Institute of Medical Sciences, Lucknow, India
#Equal contribution

Abstract

Objectives: Handgrip strength (HGS) is a key metric in cirrhosis. Multiple devices exist for HGS measurement, with gender specific cut-offs being established. However, the cut-offs do not account for potential differences between devices. We assessed the performance of the Camry EH101® handgrip dynamometer against the gold-standard Jamar® dynamometer in cirrhosis. **Methods**: This prospective observational study enrolled stable outpatients with cirrhosis (≥ 18 years). Baseline demographic and biochemical indices were assessed. HGS testing was performed by two dynamometers (Camry EH101® and Jamar®) and evaluated for correlation, systematic differences, and level of agreement. **Results**: 76 stable outpatients [48.1±12.1 years, 50 (65.7%) were males, MASLD, 77.7%] were enrolled. The overall right HGS by Jamar® and Camry EH101® dynamometers in males was 31.3±6 Kg and 25.6±7.3Kg, respectively, while it was 19.4±4.7 and15.0±3.4 in females. The correlation coefficient for right- and left-hand measurements was 0.82 (0.72-0.88) and 0.81 (0.72-0.88), respectively. Regression analysis showed no significant deviation from linearity. Bland-Altman plots for levels of agreement showed most values falling within the +/-1.96 SD range. However, there were outliers overall, representing a modest level of agreement. **Conclusion**: While the Jamar® handgrip dynamometer remains the gold standard, alternatives like the Camry EH101® dynamometer show good correlation and modest agreement.

Keywords: Cirrhosis, Co-Relation, Dynamometer, Handgrip Strength

Introduction

Handgrip strength (HGS) is a key metric for assessing muscular function and physical capacity. It has been likened to a vital sign influencing overall health by affecting diverse domains of functional disability, psychological health, hospitalization, morbidity, and mortality[1]. In individuals with cirrhosis, HGS has been shown to serve as a simple bedside predictor for malnutrition, sarcopenia, hepatic encephalopathy, and overall mortality[2,3,4]. Consequently, there has been a growing use of HGS assessment in individuals with cirrhosis for risk stratification[2].

With the growing use of HGS, absolute and gender-specific cutoffs have been identified both as normative data and in individuals with cirrhosis with recent efforts to develop region-specific cut-offs[5]. However, such cut-offs do not account for potential differences between measurement devices[6]. Systematic reviews on HGS have identified more

The authors have no conflict of interest.

Corresponding author: *Dr Mahesh K. Goenka, MD, DM, FACG, FASGE, FRCP, Department of Gastroenterology, Institute of Gastrosciences and Liver Transplantation, Apollo Multispeciality Hospitals, Kolkata, 700054, India*

E-mail: *mkgkolkata@gmail.com apollogastroenterology@gmail.com*

Edited by: *Yannis Dionyssiotis*

Accepted *18 March 2026*

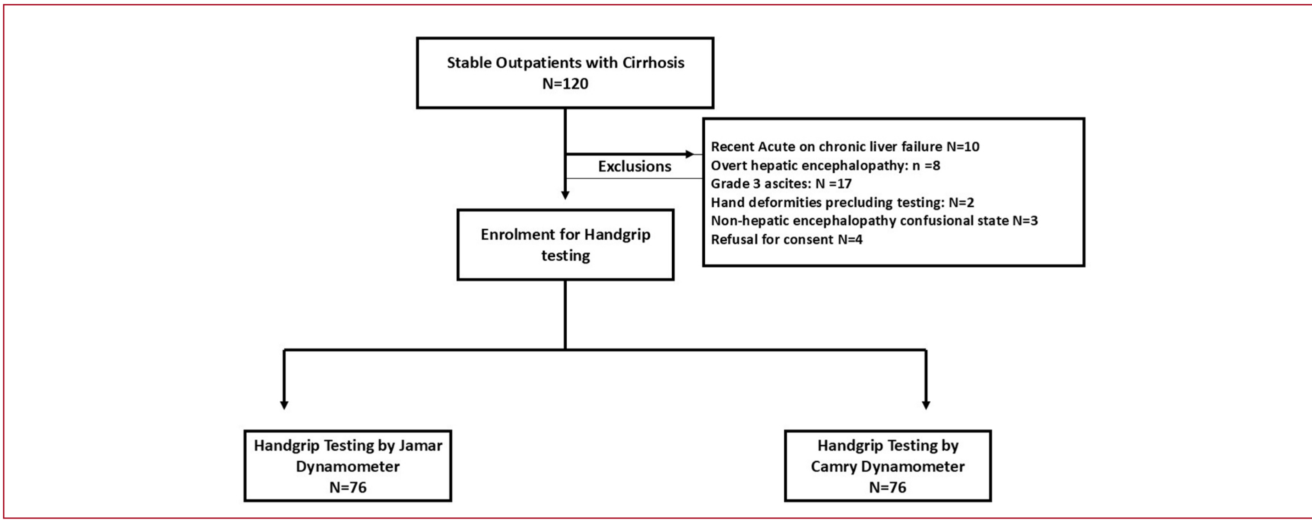


Figure 1. Study flow diagram.

than ten devices used across different studies[7]. The Jamar® dynamometer (5030J1 Lafayette Instrument Company, USA) is a hydraulic-type dynamometer commonly used in clinical practice. It has been shown to have high intra- and interindividual reliability and precision and has available normative data[8,9]. Given the robustness of the data available with this dynamometer, some societies, like the American Society of Hand Therapists, recommend it as the gold standard[10]. However, the costs associated with the Jamar® dynamometer are an important limitation in resource-limited settings and when advocating for widespread usage[11]. Consequently, as the cost of dynamometers becomes an important determinant, low-cost alternatives need to be explored. The Camry EH101® provides one such low-cost alternative and has been used in individuals with cirrhosis[8,12].

Inter-instrument comparisons between hand-held dynamometers have been performed in older and community-dwelling adults[13]. Recently, the Camry EH101® has been compared to the Jamar® dynamometer in older adults before surgery, showing excellent correlation and concordance[8]. However, no studies exist in individuals with cirrhosis that compare alternative options with the gold-standard Jamar® dynamometer. In this context, we hypothesized that the Camry EH101® is a reliable tool to assess HGS in stable outpatients with cirrhosis compared to the Jamar® dynamometer and aimed to determine levels of agreement between the two dynamometers.

Materials and Methods

Study design and settings

This prospective observational study was conducted between January 2024 and December 2024 in stable outpatients with cirrhosis who attended a dedicated liver and nutrition clinic at a tertiary care hospital in eastern India.

Study objectives

To determine the correlation and level of agreement between the two dynamometers in stable outpatients with cirrhosis.

Selection criteria

Stable outpatients with cirrhosis aged above 18 years of age were included. Individuals with acute on chronic liver failure, overt hepatic encephalopathy, grade three ascites, chronic kidney disease (stage III or above), pregnant or lactating females, those with hand deformities or pain precluding performance of HGS testing, those with previous upper extremity surgery, cervical radiculopathy, entrapment neuropathy, myopathies or other conditions likely to impair upper limb strength, those with non-hepatic encephalopathy confusional state or dementia and with hepatocellular carcinoma or extrahepatic malignancies were excluded.

Study procedures and measurements

Anthropometry: Anthropometric measurements were taken using standard procedures and devices. Participants were asked to remove shoes and extra clothing before measurements. Weight was measured to the nearest 0.2 Kg, and height was measured to the nearest 0.5 cm. The body mass index (BMI) was calculated using the individual's height and weight.

Parameter	Overall (76)	Males (n=50)	Females (N=26)
Age (years)	48.1±12.1	45.7±11.8	52.9±11.5
Aetiology			
MASLD	59 (77.7)	34 (68)	25 (96.2)
ARLD	12 (15.8)	12 (24)	0 (0)
HBV	3 (3.9)	3 (6)	0 (0)
Cryptogenic	1 (1.3)	1 (2)	0 (0)
Autoimmune	1 (1.3)	0 (0)	1 (3.8)
Body mass index (Kg/m^2)	26.6 (22.5-29.05)	26.5 (22.3-29.5)	26.5 (23.5-28)
Haemoglobin	10.4 (9.1-11.7)	10.4 (8.9-11.8)	10.4 (9.4-11)
Total Leucocyte count (/mm^3)	4.8 (3.6-5.9)	5.1 (4-6.6)	4.3 (3.3-5)
Platelet Count (/mm^3)	113.5 (80-150)	119 (90-160)	110 (56-130)
Total Bilirubin (mg/dl)	1.1 (0.9-1.6)	1.1 (0.9-1.6)	1.1 (0.7-1.6)
Direct Bilirubin (mg/dl)	0.3 (0.2-0.5)	0.3 (0.2-0.4)	0.3 (0.2-0.5)
ALT (IU/l)	31 (20-44)	30 (18-44)	31 (22-37)
AST (IU/l)	40 (32-53.5)	39 (28.7-56.2)	43.5 (36-48)
ALP(IU/l)	106 (77-147.5)	107 (77-143.7)	103 (79-167)
Protein (g/dl)	7.3 (6.9-7.5)	7.3 (6.8-7.8)	7.2 (7-7.9)
Albumin (g/dl)	3.4 (3.1-4.1)	3.4 (3.1-4.1)	3.2 (3.1-4)
INR	1.2 (1.1-1.3)	1.1 (1.1-1.3)	1.2 (1.1-1.3)
Urea (mg/dl)	30 (24-36.5)	29 (23.7-34.2)	33 (24-40)
CTP Status (A/B/C)	28/41/7	16/27/7	12/14/0
Creatinine (mg/dl)	0.9 (0.9-1.3)	0.9 (0.8-1.1)	1.1 (0.9-1.3)
Right Hand Grip Strength (Kg)			
Jamar	27.2±8.2	31.3±6.5	19.4±4.7
Camry EH101®	22.0±7.1	25.6±7.3	15.0±3.4
Left Hand Grip Strength (Kg)			
Jamar	26.2±8.7	30.2±7.2	18.4±5.5
Camry EH101®	20.4±8.4	23.1±7.7	13.6±4.9

MASLD, Metabolic dysfunction associated steatotic liver disease; ARLD, Alcohol related liver disease; HBV, Hepatitis B virus; ALT, Alanine transaminase; AST, Aspartate transaminase; INR, International normalized ratio; CTP, Child Turcotte Pugh.

Table 1. Baseline characteristics of the study population.

Handgrip dynamometry

Instrument details and Calibration: The Jamar 5030J1 hand dynamometer is manufactured by the Lafayette Instrument Company, Lafayette, Indiana, USA, while Zhongshan Camry Electronic, Zhongshan, Guangdong, China, manufactures the Camry EH101® hand dynamometer. Both dynamometers were calibrated according to the manufacturers' specifications before the study and maintained under standard procedures throughout the study.

Method: Before measurement, participants were shown the procedures of the two devices. For all measurements, the grip width of the Jamar hand dynamometer was set to the second handle position from the inside. Studies suggest that forearm position may affect grip strength[10,13]. Hence, the forearm position was kept uniform for all participants in each case. The hand grip strength of both hands was measured for each device. The participant sat in a chair with one dynamometer held in each hand, with the shoulder adducted and neutrally rotated, the elbow flexed at a 90-degree angle, the forearm in a neutral position, and the wrist in a neutral position. Participants were given

Measurements	Right hand dynamometry	Left hand dynamometry
Standard error of mean (SEM)		
Jamar	0.94	0.97
Camry EH101®	0.92	1.00
Systemic differences (Intercept A, 95%CI)	-2.7 (-7.3 to 0.94)	-4.2 (-7.5 to -1.19)
Proportional differences (Slope B, 95% CI)	0.90 (0.76 to 1.08)	0.95 (0.81 to 1.09)
Random Differences (RSD±1.96RSD Interval)	3.49 (-6.5 to 6.85)	3.71 (-0.72 to 7.27)
Linear model validity	No significant deviation from linearity (p=0.71)	No significant deviation from linearity (p=0.89)
RSD, Residual standard deviation; CI, Confidence interval.		

Table 2. Passing Bablok regression for comparison of JAMAR and Camry EH101® handgrip dynamometers.

a motivational stimulus and asked to squeeze the device as hard as possible for 3 seconds and then relax. In the case of both devices, a single attempt was made on both right and left hands to avoid pain and discomfort, which was recorded in multiple trials. A 2-minute rest period was provided between measurements in two devices. The maximal force exerted on the Jamar hand dynamometer was recorded to the nearest 2.0 Kg using the analogue dial marker and estimated by the researcher to the nearest 1 Kg by visual inspection of the gauge needle's position between the 2.0 Kg markers. Using the digital marker, the maximal force exerted on the Camry EH101® hand dynamometer was recorded to the nearest 0.1 Kg. A visual demonstration of both dynamometers being in action is shown in Supplementary Figure 1(a) and (b).

Statistical Analysis

For a two-group (Jamar® and Camry EH101®) comparison, a sample size of 64 participants was determined to be adequate with an alpha < 0.05 (risk of type I error) and beta = 0.8 (risk of type II error), as previously described by Benton et al.[6]. We enrolled 76 participants. The normality of the data was assessed using the Shapiro-Wilk test. Based on normality, data were expressed as mean ± standard deviation or median (interquartile range). Pearson correlation was performed to assess the correlations between the two devices. We considered an r > 0.8 to indicate a strong positive correlation. We also calculated the intraclass corelation coefficient (ICC). Passing and Bablok (P-B) regression was used to compare the two techniques and look for systemic and random differences. Visual analysis of the residual plot of P-B regression was done to ensure no definitive patterns emerge so that linearity is established. Bland-Altman analysis assessed the level of agreement between the two devices by plotting differences ± 2 standard deviations against mean values. The Bland-Altman plots were visually assessed for characteristics demonstrating levels of agreement, including mean values close to zero, uniform distribution over the measurement range, and 95% of differences within ± 2 standard deviations. The 95% limits of agreement were defined as bias ± 1.96 standard deviations of the difference[14]. All statistical analysis were done with SPSS version 26.0 (SPSS Inc., Chicago, IL, USA) and MedCalc 20.0 (MedCalc, Mariakerke, Belgium).

Results

Baseline characteristics and dynamometry

After satisfying the appropriate selection criteria, seventy-six stable outpatients with cirrhosis were included. The study flow diagram is shown in Figure 1. The baseline characteristics of the population is shown in Table 1. The mean age of the study population was 48.1±12.1 years, and 50(65.7%) were males. Metabolic dysfunction-associated steatotic liver disease (MASLD) was the most common etiology (77.7%). The overall right HGS by Jamar® and Camry EH101® dynamometers in males was 31.3±6 Kg and 25.6±7.3Kg, respectively, while it was 18.4±5.5and 13.6±4.9 in females. (Table 1).

Correlation between JAMAR and Camry EH101® handgrip dynamometers

The correlation coefficient between the two dynamometers for right-hand measurements was 0.82 (0.72-0.88), and for the left-hand measurements, it was 0.81 (0.72-0.88). When stratified by sex, the correlation between the two dynamometers, specifically looking at male sex gender, was 0.72(0.62-0.82). The heat maps for co-relation between the two dynamometers stratified by gender are shown in Figure 2. The ICC between Camry and Jamar was 0.68 (95% CI 0.56–0.77) for the right

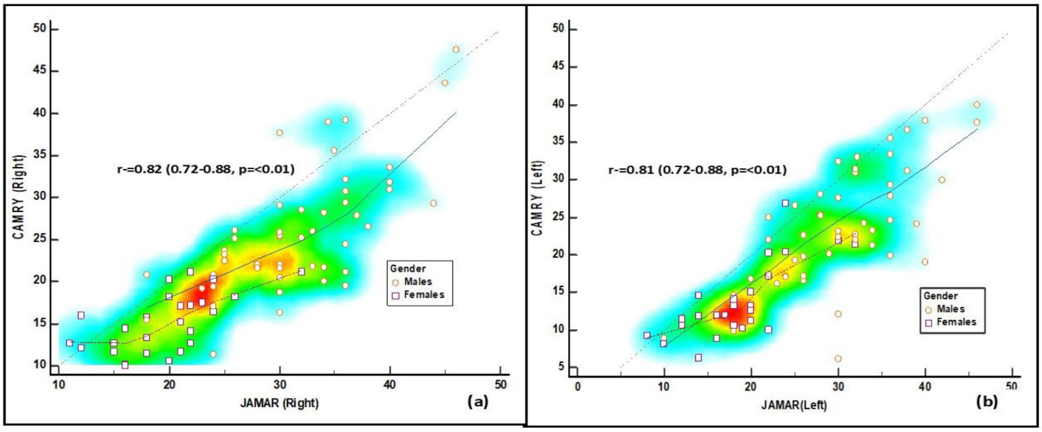


Figure 2. Correlation heat map between Jamar and Camry handgrip dynamometers: (a) right hand and (b) left hand, stratified by sex (as indicated in the figure).

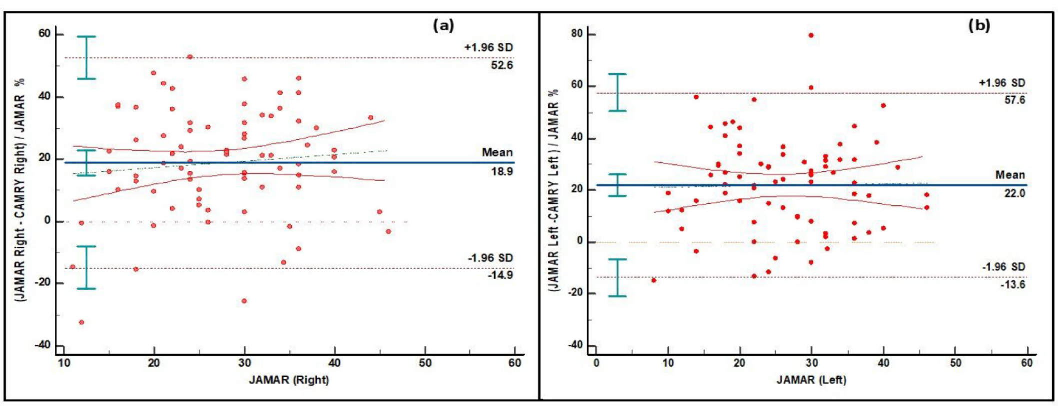


Figure 3. Bland–Altman analysis plot for comparison of the JAMAR and CAMRY EH101®: (a) right hand and (b) left hand.

and 0.67 (95% CI 0.54–0.77) for the left hand. In a sex-stratified analysis, agreement was moderate in men [right ICC 0.53 (0.34–0.67); left 0.52 (0.32–0.69)]. In women, estimates were less precise (right: 0.38 [0.20–0.51]; left: 0.53 [0.30–0.68]), predominantly driven by low sample sizes.

PB-regression and levels of agreement

Table 2 shows the measurements for PB regression analysis, revealing no significant deviation of linearity. Supplementary Figure 2 (a) (b) shows residual plots showing no definitive patterns, thereby ascertaining a linear relationship between the two measurements. Figure 3 shows the Bland-Altman plots for levels of agreement between the two dynamometers, showing most of the values falling within the +/-1.96 SD range, although there was a presence of outliers overall representing a modest level of agreement.

Discussion

HGS assessment is a key measure in evaluating the overall health of individuals, especially in older adults[15].

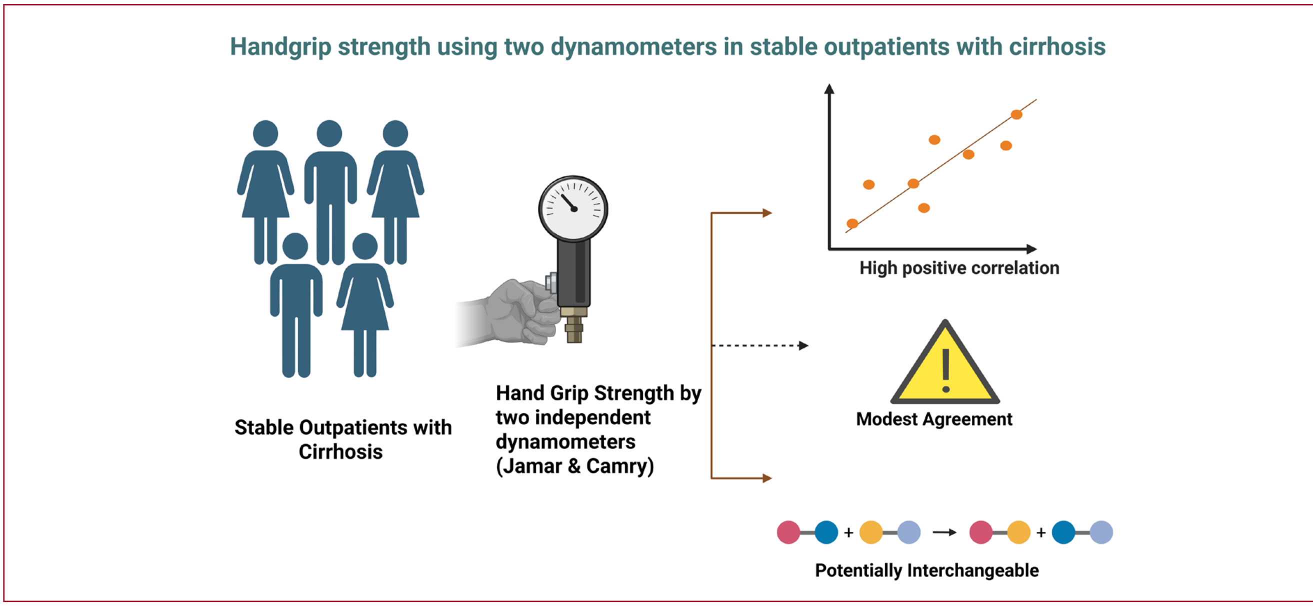


Figure 4. Graphical abstract demonstrating the key findings. Created with BioRender.com.

Multiple devices are available, and comparisons between the measures have been made, primarily in older community dwellers[13]. HGS has prognostic implications in cirrhosis and has evolved as a core assessment parameter in clinical practice[3]. Hence, it needs to be adopted widely at all levels of healthcare for individuals living with cirrhosis. However, a knowledge gap remains whether readily available, economically cheaper devices can replicate the results obtained by suggested gold-standard instruments in individuals with cirrhosis. In this prospective study of stable outpatients with cirrhosis, we evaluated a low-cost digital dynamometer (Camry EH101®) against the reference hydraulic device (Jamar®) for handgrip strength (HGS) assessment. The principal finding is that the two instruments track strength in a broadly similar manner, but they do not yield interchangeable absolute values. (Figure 4).

Benton and colleagues compared the Jamar dynamometer with the Smedley spring handgrip dynamometer in a prior study of older adults. They showed excellent reliability between the two measures, with a correlation coefficient of >0.90 [6]. However, the study observed low levels of agreement between the two methods, similar to the current findings showing an excellent correlation (r>0.80) but significant mean differences in levels of agreement. The Camry EH101® dynamometer has been compared to the Jamar dynamometer in older adults before elective surgery[8]. The maximal right handgrip strength averaged 26.9 kg ± 9.6, 26.9 kg ± 9.7 (right hand) and 25.5 kg ± 9.5, 25.7 kg ± 9.2 (left hand) with the Camry EH101® and Jamar® dynamometer, respectively. While the correlation was excellent (r>0.9), the authors reported good agreement without any systemic bias in contrast to the current study[8]. In another study of inpatients from varied specialities, the Bodygrip, which has a design more similar to the Jamar dynamometer, was compared and shown to exhibit excellent inter-instrument reliability[16]. Hence, most studies report excellent correlation, although some degree of discordance in levels of agreement remains. Variations in agreement between two instruments may stem from multiple factors, such as instrument resolution, dimensions (smaller versus larger), weight (light versus heavy), and ergonomics related to the dynamometer handles. A recent elegant study of findings from a randomized cross-over trial showed that the prevalence of low muscle strength varied by dynamometer, ranging between 3% and 22% for men and 3% and 15% for women[17]. Such findings are important as it may be unrealistic to expect all research and clinical facilities to utilize the same measurement devices. In this context, it will be important to consider developing correction factors to account for measurement differences between devices or develop different reference values and cut-points for different types of measurement devices[17,18].

While prior studies have evaluated instrument comparisons in mixed inpatient populations, pre-operative subjects, or older community-dwelling older adults, the current study uniquely focuses on individuals. with cirrhosis. HGS in cirrhosis is a reliable tool for nutrition screening, predicts sarcopenia, is associated with minimal hepatic encephalopathy and risk of overt he and has overall additive prognostic value in addition to established scores like Model for End Stage Liver Disease (MELD)[2,4,3,19]. Changes in grip strength are associated with worsening of sarcopenia which in turn predicts poor outcomes[20,21]. Hence, HGS measurement has evolved to be a part of the comprehensive assessment in cirrhosis and needs to be widely practiced. Using economically cheaper instruments like the Camry EH101® hand grip dynamometer can lead to more widespread adoption of HGS assessment in low-middle income countries as has been used in few studies[12].

However, evidence from the current study highlights the importance of carefully considering measurements across different devices. The modest agreement despite a strong correlation emphasizes the risk of misclassification when using devices interchangeably in cirrhosis. This distinction between correlation and agreement is clinically important. Correlation quantifies association and preserves ordering, whereas agreement determines whether the same numeric cut-off can be applied across devices. A systematic downward shift as observed with Camry EH101®, can therefore lead to misclassification if Jamar®-derived cut-offs are applied without adjustment. Variability is likely due to differences in handle ergonomics, measurement resolution, and patient comfort. Clinicians and researchers should exercise caution when interpreting HGS cutoffs across various devices, as diagnostic thresholds for sarcopenia or frailty may vary. It may be necessary to develop device-specific reference values or apply correction factors to maintain consistency across settings as given the current results the devices should not be considered as interchangeable.

An important limitation is the heterogeneity of cirrhosis etiologies, since medical treatment may affect muscle strength. Although most of our cohort had MASLD, future studies should focus on homogeneous groups with the same etiology and similar disease duration. Furthermore, in the current study, only one measurement per instrument was taken per participant by a single observer; therefore, intra-observer repeatability could not be estimated. Future studies should include repeated measures to quantify same-rater repeatability. Lastly, agreement estimates in women were less precise because of a smaller sample size and need a larger representation in future studies.

From a clinical and research standpoint, our findings support several practical recommendations. First, Camry EH101® appears suitable for screening and longitudinal monitoring, provided the same device is used consistently because the relationship with Jamar® is approximately linear. Second, Camry EH101® and Jamar® should not be used interchangeably when applying absolute cut-offs; otherwise, this may inflate or deflate the prevalence of low muscle strength and compromise comparability across studies and settings. Third, when HGS is used as an endpoint, studies should explicitly report device model, handle setting, positioning, and the trial protocol to facilitate uniformity.

In conclusion, HGS is an important screening tool in cirrhosis. While the Jamar handgrip dynamometer remains the gold standard, alternatives like the Camry EH101® dynamometer show good correlation but only modest agreement. Future studies should focus on determining ideal references and instrument-based cut-offs for HGS measurement.

Ethics approval

Ethical approval for the study was granted by the Institutional Review Board of IEC Apollo Multispeciality Hospitals, Kolkata, India (IEC/BR/03/12). The study was conducted in accordance with the Declaration of Helsinki 1964 and its later amendments.

Authors' contributions

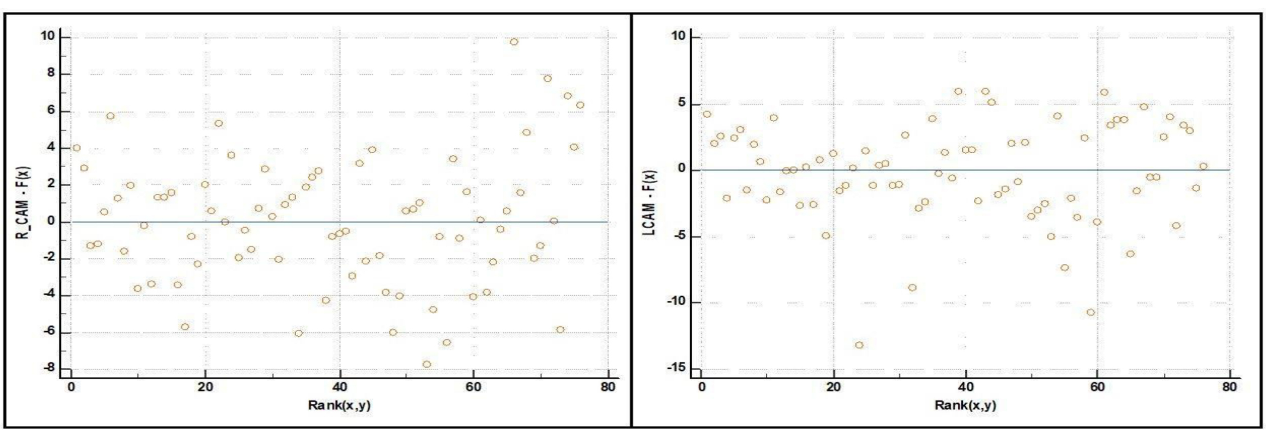
SC: Resources and project administration; writing – original draft; formal analysis; writing – review and editing. AR: Conceptualization (lead); writing – original draft; formal analysis; writing – review and editing. MS: Resources and project administration. SS: review and editing. AT: Resources. NS: Resources. UCG: Resources. MKG: review and editing. All authors read and approved the final version of the manuscript.

References

1. Vaishya R, Misra A, Vaish A, Ursino N, D'Ambrosi R. Hand grip strength as a proposed new vital sign of health: a narrative review of evidences. Journal of Health, Population and Nutrition. 2024;43(1):7.
2. Shasthry V, Kapoor PB, Tripathi H, Kumar G, Joshi YK, Benjamin J. Handgrip strength: Best practice for a rapid nutrition screening and risk stratification in male patients with alcoholic liver cirrhosis, a classification and regression tree analysis study. Nutrition in Clinical Practice. 2024;39(2):475-84.
3. Singh S, Taneja S, Roy A, Rathi S, De A, Verma N, et al. Simple bedside tests of muscle strength and function correlate with computed tomography-skeletal muscle index for assessment of sarcopenia in cirrhosis. Indian Journal of Gastroenterology. 2023;42(3):379-87.
4. Miwa T, Hanai T, Nishimura K, Maeda T, Ogiso Y, Imai K, et al. Handgrip strength stratifies the risk of covert and overt hepatic encephalopathy in patients with cirrhosis. Journal of Parenteral and Enteral Nutrition. 2022;46(4):858-66.
5. Rajendiran S, Pai GM, Verma V, Rajappa S, Bhat A, Gaba S, et al. Normative Data of Grip Strength and Pinch Strength in the Indian Population. Indian Journal of Plastic Surgery. 2024;57(04):256-62.
6. Benton MJ, Spicher JM, Silva-Smith AL. Validity and reliability of handgrip dynamometry in older adults: A comparison of two widely used dynamometers. PLOS ONE. 2022;17(6):e0270132.
7. Mafi P, Mafi R, Hindocha S, Griffin M, Khan W. A systematic review of dynamometry and its role in hand trauma assessment. The open orthopaedics journal. 2012 ;6:95.
8. Andrade MS, Honorato MP, Vargas JP, De Los Angeles Galvez M, Rojas MR. Comparison of two handgrip dynamometers in

older adults before elective surgery. Perioperative Medicine. 2023;12(1):46
9. Peters MJH, Van Nes SI, Vanhoutte EK, Bakkers M, Van Doorn PA, Merkies ISJ, et al. Revised normative values for grip strength with the Jamar dynamometer. Journal of the Peripheral Nervous System. 2011;16(1):47-50.
10. Hogrel J-Y. Grip strength measured by high precision dynamometry in healthy subjects from 5 to 80 years. BMC Musculoskeletal Disorders. 2015;16(1):139
11. Jurak G, Morrison SA, Soric M, Leskošek B, Kovač M, Ocvirk T, et al. SLOfit Lifelong: A model for leveraging citizen science to promote and maintain physical fitness and physical literacy across the lifespan. Frontiers in Public Health. 2022;10:1002239.
12. De A, Kumari S, Kaur A, Singh A, Kalra N, Singh V. Hand-grip strength as a screening tool for sarcopenia in males with decompensated cirrhosis. Indian Journal of Gastroenterology. 2022;41(3):284-91.
13. Huang L, Liu Y, Lin T, Hou L, Song Q, Ge N, et al. Reliability and validity of two hand dynamometers when used by community-dwelling adults aged over 50 years. BMC Geriatrics. 2022;22(1):580
14. Martin Bland J, Altman D. Statistical Methods For Assessing Agreement Between Two Methods Of Clinical Measurement. The Lancet. 1986;327(8476):307-10.
15. Kim SH, Kim T, Park J-C, Kim YH. Usefulness of hand grip strength to estimate other physical fitness parameters in older adults. Scientific Reports. 2022;12(1):17496
16. Guerra RS, Amaral TF, Sousa AS, Fonseca I, Pichel F, Restivo MT. Comparison of Jamar and Bodygrip Dynamometers for Handgrip Strength Measurement. Journal of Strength and Conditioning Research. 2017;31(7):1931-40.
17. Cooper R, Lessof C, Wong A, Hardy R. The impact of variation in the device used to measure grip strength on the identification of low muscle strength: Findings from a randomised cross-over study. Journal of Frailty, Sarcopenia and Falls. 2021;06(04):225-30.
18. Roberts HC, Denison HJ, Martin HJ, Patel HP, Syddall H, Cooper C, et al. A review of the measurement of grip strength in clinical and epidemiological studies: towards a standardised approach. Age and Ageing. 2011;40(4):423-9.
19. Sinclair M, Chapman B, Hoermann R, Angus PW, Testro A, Scodellaro T, et al. Handgrip Strength Adds More Prognostic Value to the Model for End-Stage Liver Disease Score Than Imaging-Based Measures of Muscle Mass in Men With Cirrhosis. Liver Transplantation. 2019;25(10):1480-7.
20. Endo K, Kakisaka K, Kuroda H, Miyasaka A, Takikawa Y, Matsumoto T. Annual changes in grip strength and skeletal muscle mass in chronic liver disease: observational study. Scientific Reports. 2023;13(1):1648.
21. Topan M-M, Sporea I, Dănilă M, Popescu A, Ghiuchici A-M, Lupuşoru R, et al. Impact of Sarcopenia on Survival and Clinical Outcomes in Patients With Liver Cirrhosis. Frontiers in Nutrition. 2021;8:766451.

Supplementary Figure 1. Real-life performance of handgrip testing.



Supplementary Figure 2. Residual plots of the Passing–Bablok regression. As evident from the plots, there are no definitive patterns, thereby ascertaining a linear relationship between the two measurements.