Section: Miscellaneous

Original Research Article

SONOGRAPHIC ASSESSMENT OF SARCOPENIA BY MORPHOMETRY OF PSOAS MUSCLE IN PREDICTING THIRTY-DAY MORTALITY IN CHRONICALLY ILL PATIENTS ADMITTED IN A TERTIARY CARE HOSPITAL

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ABSTRACT

Background: Sarcopenia is a progressive, generalized skeletal muscle disease with the loss of muscle mass and function, associated with adverse outcomes and poor prognosis. Muscle ultrasound (US) is a feasible and practical tool to predict sarcopenia. It has distinct advantages over other available modalities for muscle mass because the tool allows for separate measurements of individual muscle groups in addition to being safe and portable. Hence the current study was to identify sarcopenia and to predict 30-day mortality in chronically ill patients admitted in a tertiary care hospital.

Material and Methods: A prospective observational study was done during February 2023 – September 2025 in 70 chronically ill patients admitted in a tertiary care hospital. Purposive sampling method was used. Institutional ethical clearance and patients informed consent was obtained. Sonographic psoas muscle indices were calculated. Statistical analysis was done using independent sample t test and spearmans correlation. Cut off of psoas muscle indices to predict 30-day mortality were estimated using youdens index, Receiver operating curve and area under the curve. Diagnostic accuracy of these indices were estimated in predicting 30-day mortality.

Results: Psoas muscle area, Psoas muscle thickness index and psoas muscle area index was significantly less in patients who died in 30 days where as Psoas muscle thickness though low was not significant statistically, when compared to patients who survived after 30 days. AUC shows good and fair performance of PMTI and PMAI with values 0.852 and 0.635. Youdens index or J value shows the cutoff for PMAI and PMTI for predicting 30-day mortality was 197mm2/m2 and 17.2 mm/m respectively.

Conclusions: ROC curve of PMAI and PMTI shows good predictability of the two measures for 30-day mortality as they lie above the reference line where PMTI was better compared to PMAI.

Keywords: sonography, psoas muscle indices, thirty-day mortality, chronically ill, sarcopenia.

INTRODUCTION

According to the European Working Group on Sarcopenia in Older People (EWGSOP), sarcopenia is defined as a "a syndrome characterised by progressive and generalised loss of skeletal muscle mass and strength with a risk of adverse outcomes such as physical disability, poor quality of life and death".[1]

Sarcopenia is a progressive, generalized skeletal muscle disease with the loss of muscle mass and function, associated with adverse outcomes and poor prognosis. Sarcopenia first was regarded as an age-related disorder of older people (primary sarcopenia). Later it turned out that it can also occur in young age due to a range of chronic disorders such as cancer, anorexia or malnutrition (secondary sarcopenia).[2]

sarcopenia is considered a patient-specific imaging biomarker able to predict clinical outcomes. In addition to basic clinical methods such as measuring muscle strength several imaging modalities, including dual-energy X-ray absorptiometry (DXA), computed tomography (CT), magnetic resonance (MR), and ultrasound (US), can be used to assess muscle mass and quality and to achieve the diagnosis of sarcopenia.[3,4]

Muscle mass can be assessed accurately using imaging methods. CT scans and magnetic resonance (MR) imaging are precise, however both methods are expensive and one implies exposure to ionizing radiation. Double energy X-ray examination (DEXA) accurately assesses lean mass and is used as a gold standard. It is inexpensive and has a low re-test error. Its drawbacks are that the large equipment required precludes its use in field studies and that in patients with fluid management problems, the measurements can alter. Muscle ultrasound is a feasible and practical tool to predict sarcopenia. It has distinct advantages over other available modalities for muscle mass because the tool allows for separate measurements of individual muscle groups in addition to being safe and portable.[5] Muscle ultrasound shows a low-to-moderate diagnostic test accuracy for sarcopenia diagnosis depending on different ultrasound parameters, measured muscles, reference standards and study populations.[6]

Ultrasound measurement of muscle mass can represent a quick and inexpensive method for detecting of muscle mass loss and qualitative changes even in the presence of acute and chronic diseases as imbalances in body fluids being also comparable to other techniques such as DEXA, CT or MRI.[7,8,9]

Similarly, radiologists should master the culture of sarcopenia, and its clinical aspects and relevant implications for better patient care.[10] The importance of sarcopenia is already well studied for patients with various tumor entities, elderly, liver pathology and also infections such as SARS-COV2 but still there is no literature in chronically terminally ill patients. Hence the current study was to identify sarcopenia and to predict 30-day mortality in chronically ill patients admitted in a tertiary care hospital.

MATERIALS AND METHODS

A prospective observational study was done during February 2023 – September 2025 in 70 chronically ill patients admitted in a tertiary care hospital. Purposive sampling method was used. Institutional ethical clearance and patients informed consent was obtained.

Inclusion Criteria: Adults of either sex who were chronically and terminally ill for more than 6 months were included. Exclusion criteria includes pregnant women, ingestion of medications which could affect muscle function such as adrenal steroids or anabolic drugs, alcoholism, drug abuse and those who were not willing to participate in the study.

Data on patients age, gender, comorbidities, diagnosis at the time of admission were recorded. Sonographic morphometry of Psoas muscle indices were recorded. Outcome recorded was 30-day mortality. Instrument used for imaging was Philips US scanner (Philips Healthcare Affiniti 70 G, USA) using an optimized gain by the same radiologist. Data recorded were described as frequencies and percentages or mean and SD or median as applicable. All patients lay in supine position for sonographic examination as body position could affect muscle dimensions.[11] The psoas muscle was depicted in the frontal plane above the iliac crest and the psoas muscle thickness was measured at the level of the caudal kidney pole to obtain reproducible results.

Based on these measurements the psoas muscle thickness index (PMTI), and psoas muscle area index PMAI were calculated.[12,13] The PMTI is obtained from the average bilateral psoas muscle thickness indexed to the body height of the patient (mm/m). PMAI incorporates the average bilateral psoas muscle area indexed to the squared body height of the patient (mm^2/m^2). The average bilateral psoas muscle area for the PMAI is approximated from the M. psoas diameter by the formula for a circular surface.[12]

Statistical analysis was done using independent sample t test (as the variables were normally distributed) between mean of psoas muscle indices versus 30-day mortality. Cut off of psoas muscle indices to predict 30-day mortality were estimated using Receiver operating curve and area under the curve. Diagnostic accuracy of these indices were estimated in predicting 30-day mortality. Statistics like positive predictive value (PPV), negative predictive value (NPV), sensitivity, specificity, and accuracy were calculated with 95% Confidence intervals.[14] The level of significance (p-value) is considered as 0.05. Statistical software used was IBM SPSS version 22.0 (SPSS Inc, Chicago IL) and MEDCALC.

RESULTS

Data collected from 70 chronically ill patients. Mean age of the patients was 62.7±12.8 with range 42-86 years. Mean weight of the patients was 52.8±15.7 with range 34-108 kgs. Mean height of the patients was 1.57 m ± 0.46 with range 1.43-1.76 meters. Mean BMI of the patients was 21.6 ± 3.64 with range 10.7-35.7 cms. [Table 1]

Table 1: Distribution by patient's characteristics and psoas muscle indices

Variables	Minimum	Maximum	Mean	Std. Deviation
Age in years	42	86	62.7	12.8
weight in kgs	34	108	52.8	15.7
height in meters	1.43	1.76	1.57	0.46
BMI	10.7	35.7	21.6	3.64

There were 45(64.3%) male and 25 (35.7%) female patients. Organ dysfunction/ failure was the most common reason for chronic illness, followed by infections, road traffic accidents and cancers. Others include selenity and lifestyle disorders. 30-day mortality was seen in 20 (28.5%) patients. [Table 2]

Table 2: Frequency distribution of patient characteristics

Variables	Subgroup	Frequency	Percentage
Gender	Male	45	64.3%
	Female	25	35.7%
Diagnosis	Cancers	4	5.7%
	Road traffic accidents	15	21.4%
	Infections	19	27.1%
	Organ dysfunction/ failure	27	38.6%
	Others	5	7.1%
30-day mortality	Yes	50	71.5%
	No	20	28.5%

Sonographic muscle assessment showed mean psoas muscle thickness of the patients was 32.6 mm ± 5.94 with range 24.7-37.1 mm. Mean psoas muscle area of the patients was 843 mm2 ± 253.9 with range 353-1490 mm2. Mean and SD of Psoas muscle thickness Index was 18.9 ± 3.25 (mm/m) with range 15.6 - 22.5 mm/m. Mean and SD of Psoas muscle area index was 231± 56.25 (mm^2/ m^2) with range of 156 – 398 (mm^2/ m^2). [Shown in table 3]

Table 3: Sonographic psoas muscle morphometry

Psoas muscle morphometry	Minimum	Maximum	Mean	Std. Deviation
Psoas muscle thickness in mm	24.7	37.1	32.6	5.94
Psoas muscle thickness Index (mm/m)	15.6	22.5	18.9	3.25
Psoas muscle area (mm2)	353	1490	843	253.92
Psoas muscle area index (mm2/ m2)	156	398	231	56.25

Mean of Psoas muscle area, Psoas muscle thickness index and psoas muscle area index was significantly less in patients who died in 30 days where as Psoas muscle thickness though low was not significant statistically, when compared to patients who survived after 30 days. [Table 4]

Table 4: Psoas muscle indices versus 30-day mortality

Psoas muscle indices	30-day mortality	N	Mean	Std. Deviation	T test/ p value
Psoas muscle thickness in mm	No	50	28.9800	6.05840	0.8806
	Yes	20	27.6000	5.58378	0.3816
Psoas muscle area in mm^2	No	50	962.2200	230.14195	3.3184
	Yes	20	765.2500	208.65197	0.0015
Psoas muscle thickness index	No	50	19.1015	5.23838	3.6088
	Yes	20	14.6992	2.36756	0.0006
psoas muscle area index	No	50	243.4566	92.39486	5.6825
	Yes	20	114.6988	65.06649	0.0001

ROC curve of PMAI and PMTI shows good predictability of the two measures for 30-day mortality as they lie above the reference line where PMAI was better compared to PMTI in predicting.

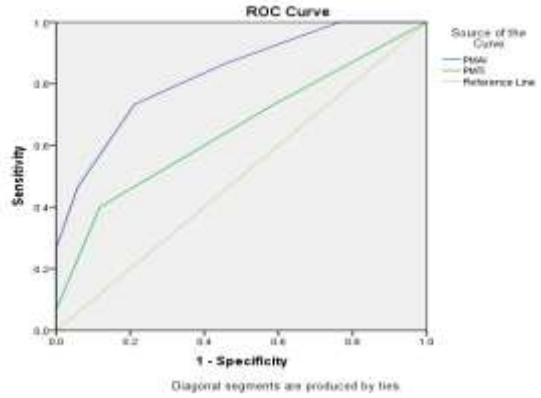

Figure 1: ROC curve of PMAI and PMTI

AUC shows good and fair performance of PMAI and PMTI with values 0.852 and 0.635. Youdens index or J value shows the cutoff for PMAI and PMTI for predicting 30-day mortality was 197mm2/m2 and 17.2 mm/m respectively. [Table 5]

Table 5: AUC for PMAI and PMTI

Area Under the Curve	Area
Psoas muscle area index	.852
Psoas muscle thickness index	.635

Table 6: PMAI and PMTI cross tabulation with 30-day mortality

Psoas Muscle indices versus 30-day mortality		30-day mortality		Total (70)	Spearmans rho/ P value
		Yes (20)	NO (50)		
PMAI	< 197mm^2/m^2 (12)	17	5	22	0.89/ 0.0012
	>197mm^2/m^2 (15)	3	45	48	
PMTI	<17.2 mm/m	18	7	25	0.732/0.006
	>17.2 mm/m	2	43	45	

Table 7: Diagnostic characteristics of PMAI and PMTI in predicting 30-day mortality

Statistic	PMAI		PMTI	
	Value	95% CI	Value	95% CI
Sensitivity	85.00%	62.2% to 96.79%	90.00%	68.30% to 98.77%
Specificity	90.00%	78.19% to 96.67%	86.00%	73.26% to 94.18%
Positive Likelihood Ratio	8.50	3.63 to 19.92	6.43	3.18 to 12.98
Negative Likelihood Ratio	0.17	0.06 to 0.48	0.12	0.03 to 0.44
Disease prevalence	28.57%	18.40% to 40.62%	28.57%	18.40% to 40.62%
Positive Predictive Value	77.27%	59.20% to 88.85%	72.00%	56.02% to 83.85%
Negative Predictive Value	93.75%	84.03% to 97.71%	95.56%	85.18% to 98.77%
Diagnostic Accuracy	88.57%	78.72% to 94.93%	87.14%	76.99% to 93.95%

DISCUSSION

The early detection and monitoring of sarcopenia in chronically ill patients can significantly influence clinical decision-making. In particular, the identification of individuals at a higher risk for sarcopenia-related complications could drive targeted interventions, including nutritional support and physical therapy.[15]

Both the CSA and MT provide numerical data, allowing for accurate comparisons over time and between individuals. It has been shown that individuals with a significant reduction in the MT and CSA may be at a higher risk for complications related to sarcopenia.[16]

In the current study males were 64.3% (45/70) where as in study by Kremer WM et al, males were 55.9% (n = 76/136). In the current study mean age was 62.7 years with standard deviation 12.8 years which was similar to study by Kremer WM et al which showed a median age of 60 years (49–69 years).[17] In study by Xu J Y et al the mean age was 63.2±11.6 years (16.0–88.0).[18] In this study mean of BMI was 21.6±3.64, where as in study by Xu JY et al the mean BMI was slightly higher 23.5±3.5 kg/m2 (16.6–39.1). In our study sonographic muscle assessment showed mean psoas muscle thickness of the patient was 32.6 mm ± 5.938 with range 24.7-37.1 mm. Mean psoas muscle area of the patients was 843 mm2 ± 253.9 with range 353-1490 mm2. These findings were similar to study by Kremer WM et al with PMT (range 31.7–61.2 mm), PMA (range 251–2,177 mm2) and PMAI (range 104–761 mm2/m2).[17] Our study findings also were in line with previously published studies by Kobayashi K et al and Hari A et al.[13,19]

In our study mean and SD of Psoas muscle thickness Index was 18.9 ± 3.25 (mm/m) with range 15.6 - 22.5 mm/m. Mean and SD of Psoas muscle area index was 231± 56.25 (mm2/ m2) with range of 156 – 398 (mm2/ m2). In study by Kremer WM et al, Sonographic assessment of the psoas muscle revealed a median PMAI of 240.4 mm2/m2 (176.4–331.7 mm2/m2) and a median PMTI of 17.5 mm/m (14.9–20.5 mm/m).[17]

In our study Youdens index or J value shows the cutoff for PMAI and PMTI for predicting 30-day

mortality was 197mm2/m2 and 17.2 mm/m respectively. The diagnostic accuracy in predicting 30-day mortality by PMAI and PMTI with cutoff value as per youdens index was 88.5% and 87.1% respectively with sensitivity of PMAI and PMTI 85% and 90% respectively, and specificity of PMAI and PMTI to be 90% and 86% respectively. Similar results were found in study by Kremer WM et al, where the optimal cutoff value of PMAI and PMTI to predict 30-day mortality was 206 mm2/m2 and 16.1 mm/m with a sensitivity of 75% and a specificity of 73%.

In our study PMTI and PMAI confirmed sarcopenia in 25 and 22 patients respectively with linear negative correlation which shows strong association (PMAI rho= 0.89, PMTI rho = 0732) which was significant statistically. In study by Chapela SP et al, the correlation between the different measurements was analyzed comparing with total psoas area ($r = 0.71$; $p < 0.01$), and with sum of area of 2 psoas ($r = 0.72$; $p < 0.001$). the sum of 2 psoas had 91.7% sensitivity and specificity (AUC = 0.82) and the total area of psoas had 83.3% sensitivity and 76.9% specificity (AUC = 0.8).[20]

CONCLUSION

PMTI and PMAI confirmed sarcopenia in 25 (35.7%) and 22 (31.4%) patients respectively with linear negative correlation which shows strong association (PMAI rho= 0.89, PMTI rho = 0.732) which was significant statistically. PMAI was a better index compared to PMTI as per ROC and AUC. Youdens index or J value shows the cutoff for PMAI and PMTI for predicting 30-day mortality was 197mm2/m2 and 17.2 mm/m respectively. The diagnostic accuracy in predicting 30-day mortality by PMAI and PMTI was 88.5% and 87.1% respectively with sensitivity of PMAI and PMTI 85% and 90% respectively, and specificity of PMAI and PMTI to be 90% and 86% respectively.

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