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Original Article

Assessment of Sarcopenia as an Independent Predictor of Post-operative Chest Complications in Patient Undergoing Elective Open Upper Abdominal Surgeries: A Prospective Observational Hospital Based Study

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Abstract

Introduction: Sarcopenia is a condition that becomes more prevalent with advancing age, as well as with many diseases and is increasingly recognized as an independent risk factor for adverse health outcomes. So Sarcopenia as a potential prognostic biomarker deserves attention. The present study demonstrated that sarcopenia itself, defined as reduced skeletal muscle mass plus low muscle strength and/or low physical performance, is an independent risk factor for pulmonary complications after elective open upper abdominal surgery.

Materials and Methods: This is a prospective study including patients who underwent elective open upper abdominal surgeries at our hospital. Sarcopenia was diagnosed by a combination of third lumbar vertebra Psoas muscle index (L3 PMI) using preoperative computed tomography scan of the abdomen and 6-m usual gait speed. The presence of postoperative pulmonary complications (PPC) was screened daily for 7 days using the Melbourne Group Scale (Version 2). Other complications were also identified and documented as per Clavien-Dindo classification.

Results: A total of 165 patients undergoing open upper abdominal surgeries were included in the study, and 20 patients were diagnosed as having sarcopenia. PPC occurred in 45 patients, including 11 with sarcopenia and 34 without sarcopenia. The sarcopenic group was significantly older and had significantly lower PMI, calf muscle circumference, and gait speed than non-sarcopenic group, but other physical parameters such as height, weight, and body mass index were not significantly different. The distribution of postoperative infectious and non-infectious diseases for 165 patients was as follows: diarrhea, 3 cases (1.82%); paralytic ileus, 11 cases (6.67%); urinary retention, 6 cases (3.64%); wound abscess, 17 cases (10.3%), with slightly more prevalence in sarcopenia group. The results of my study indicate that sarcopenia is a unique, independent preoperative predictor of pulmonary complications after elective open upper abdominal surgeries.

Conclusion: The present study demonstrated that sarcopenia itself, defined as reduced skeletal muscle mass plus low muscle strength and/or low physical performance, is an independent risk factor for pulmonary complications after elective open upper abdominal surgery.

Key words: Post-operative chest complication, Post-operative complications, Sarcopenia, Upper abdominal surgeries

INTRODUCTION

Sarcopenia- broadly defined as significant loss of muscle mass and function- is recognized increasingly as an important independent risk factor for numerous adverse outcomes.[1] The association of malnutrition with adverse clinical outcomes is well established in the literature and recognized as early as 1936. The European Union on Sarcopenia in Older People (EWGSOP) recommends using the presence of both low muscle mass and low muscle function (strength or function) for the diagnosis of sarcopenia.[2]

Loss of mass and functional capacity of skeletal muscle is a major cause of morbidity in older individuals as well as in patients affected by any acute and chronic

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conditions including infectious diseases, endocrine, and metabolic disorders, organ dysfunction, immunological diseases, vascular diseases, hematological disorders, and malignancies.[3]

Sarcopenia has also been shown to have a negative impact on patients undergoing surgery. The clinical implications of sarcopenia have been consistently associated with increased duration of hospital stay, higher costs of hospital care, higher risks of nosocomial infections, other post-operative complications and decreased survival outcomes. Sarcopenia leads to reduced mobilization, suboptimal deep breathing, and inability to perform simple activities of day-to-day life[3,4] partly explaining the increased post-operative chest complications observed in patients of sarcopenia undergoing open abdominal surgeries.

MATERIALS AND METHODS

Ethical clearance was obtained at the start of the study from the Institutional Review Board. This is an observational study. The sample size calculated to be 165, *n* (sample size) = $z_a^2 p(1-p)/e^2$; where p is proportion, e is precision. Here, a = 5% hence z_a =1.96, p (incidence) = 12%, e = 5%, n is coming out to be 163. We conducted on 165 patients over a period of 2 years from September 2018 to August 2020, in the Department of General Surgery at The Calcutta Medical Research Institute, Kolkata. A written informed consent was obtained from all the patients before enrollment. Patients were prospectively observed and followed up until discharge after surgery.

Inclusion Criteria

1. Patients between age group 18–70 years who underwent planned open upper abdominal surgeries defined as an incision above or extending above the umbilicus
2. Patients having previously done computed tomography (CT) scan of the abdomen as a part of their necessary investigations from within 30 days prior to surgery
3. Patients who agreed for follow-up for a postoperative period of 1 week or till discharge.

Exclusion Criteria

1. Patients who did not have a previously done CT scan of the abdomen from 30 days prior to the surgery
2. Patients having previous chest dysfunction such as COPD, or who were ventilated postoperatively
3. Patients with a physical deformity who were unable to be tested for muscle strength or physical performance
4. Patients who were immuno-compromised such as AIDS, undergoing chemotherapy, and who underwent palliative surgery.

We have performed a single institution, prospective review of 165 patients admitted for elective open upper abdominal surgeries in which CT scan of the abdomen was done.

For enrolled patients, the following preoperative factors: sex, age, height, weight, body mass index (BMI) were evaluated. Sarcopenia was evaluated using computed tomography and gait speed. Postoperative pulmonary complications (PPC) and other surgical complications were evaluated using Melbourne Group Scale-2 and Extended Clavien-Dindo Classification respectively.

Image Analysis of Skeletal Muscle Mass

A cross-sectional CT image at the third lumbar vertebra (L3) in the inferior direction was analysed, for example as shown in Figure 1.[5,6] The distinction between different tissues was based on Hounsfield units, using INFINITT PACS software. The muscles in the L3 region inferiorly contain paraspinal muscles-Psoas, erector spinae, quadratus lumborum. The cross-sectional area (cm^2) of the right and left psoas muscle at L3 level on CT scans was measured by manual tracing.[7] To minimize measurement bias, one investigator who was blinded to the patient outcomes was trained to identify and quantify muscle areas. The Psoas Muscle Index (PMI) was calculated as follows: PMI = total psoas muscle area/height^2 (cm^2/m^2). Sarcopenia was defined as the PMI under 3.70 cm^2/m^2 in males and 2.50 cm^2/m^2 in females, based on the morbidity criteria.

Measurement of Muscle Strength and Physical Performance

For measurement of the 6-m usual gait speed, patients were asked to walk over a 6 meter course at their usual speed. Patients begin walking from the starting line, following the examiner's command of "Go" and stop just past the finishing line. Timing was started with the first footfall and stopped when the patient's foot first completely crossed the finishing line.[8] The maximum value of three consecutive

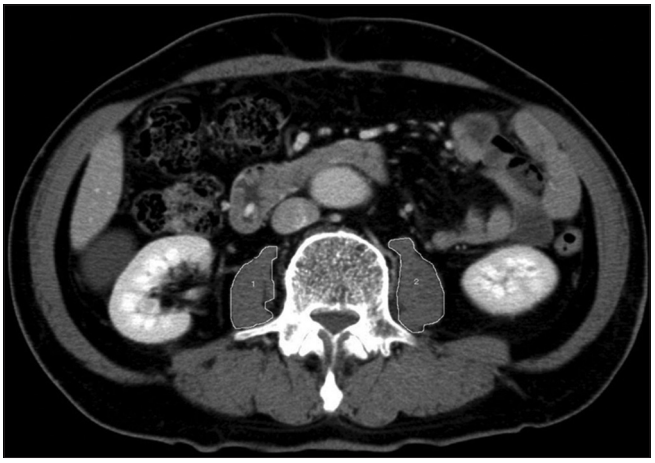

Figure 1: Cross sectional area (cm^2) of the psoas muscle at the level of the third lumbar vertebra (L3) measured by manual tracing on computed tomography

tests was recorded. The cut-off value for low physical performance was 6-m usual gait speed <0.8 m/s.

Calf muscle circumference will also be recorded at the nearest 0.1 cm at the mid level of the leg where calf girth is maximum using tape measure. Calf Circumference under 31 cm is the best clinical indicator of sarcopenia.

For BMI- Calculated as the weight divided by the height squared (kg/m^2). Patients were classified as obese (BMI ≥30 kg/m^2) or non-obese. The cut-off points for BMI to screen sarcopenia for males is 24.6 and for females is 26.2.

Presence of PPC

All participants received usual medical and nursing care as well additional monitoring from a specialized postoperative surveillance team of the hospital consisting of surgical residents and specialized intensive care unit (ICU) nursing staff during the first 7 days postoperatively (if directly admitted to the ward) or following ICU admission. No preoperative physiotherapy was provided and participants received usual care physiotherapy beginning on the 1st postoperative day. This commonly included early mobilization and education regarding the performance of deep breathing exercises and supporting coughing hourly. The presence of PPC was screened daily for the 1st week using the Melbourne Group Scale Version-2. Information collected included: oxygen saturation, temperature, auscultatory changes, and sputum colour. Sputum culture, white cell count, and chest radiograph results were reviewed when ordered by the treating doctor and were classified as normal or abnormal according to the pathology and radiology reports.

Presence of other Postoperative Surgical Complications

During the postoperative evaluation for PPC, participants were also looked for any other postoperative complications as per the definitions of Extended Clavien-Dindo Classification. Patients with Grade 2 or higher adverse events occurring during hospitalization were considered to have complications.

RESULTS

A total of 165 patients undergoing open upper abdominal surgeries were included in the study, and 20 patients were diagnosed as having sarcopenia. PPC occurred in 45 patients, including 11 with sarcopenia and 34 without sarcopenia. The sarcopenic group was significantly older and had significantly lower PMI, calf muscle circumference, and gait speed than non-sarcopenic group, but other physical parameters such as height, weight, and BMI were not significantly different. The various parameters with respect of sarcopenia are discussed in details in Table 1.

The distribution of postoperative infectious and non-infectious diseases for 165 patients was as follows: diarrhea, 3 cases (1.82%); paralytic ileus, 11 cases (6.67%); urinary retention, 6 cases (3.64%); wound abscess, 17 cases (10.3%), with slightly more prevalence in sarcopenia group. The results of my study indicate that sarcopenia is a unique, independent preoperative predictor of pulmonary complications after elective open upper abdominal surgeries.

DISCUSSION

Sarcopenia, as first reported by Rosenberg in 1989, was defined as the reduction of an elderly person's skeletal muscle. In 2010, the EWGSOP redefined sarcopenia as the progressive decline of skeletal muscle area, strength and function. It was initially introduced as long-term prognostic factor in patients with advanced cancer but subsequent

Table 1: Relation of Age, Weight, Height, BMI, Calf muscle circumference, PMI, Giat speed, sPO2, Temperature with respect to sarcopenia

Parameters	Sarcopenia						*P*-value	Significance
	No			Yes				
	Mean	Median	Std. Deviation	Mean	Median	Std. Deviation		
Age	53.47	53.00	5.78	59.50	60.00	4.63	<0.001	Significant
Weight	70.50	69.00	6.49	66.25	66.00	7.97	0.001	Significant
Height	1.68	1.69	0.04	1.67	1.69	0.07	0.437	Not Significant
BMI	24.84	24.40	2.21	23.79	23.45	2.31	0.022	Significant
Calf Muscle Circumference	31.82	31.80	0.58	30.67	30.35	0.82	<0.001	Significant
PMI	3.71	3.90	0.53	3.11	3.30	0.57	<0.001	Significant
Gait Speed	1.47	1.40	0.27	0.76	0.70	0.29	<0.001	Significant
SPO2	96.01	97.00	3.54	92.30	92.00	3.73	<0.001	Significant
Temperature	38.26	38.00	1.16	39.12	39.25	1.15	0.003	Significant

BMI: Body mass index, PMI: Psoas Muscle Index

studies found that sarcopenia can be used as a preoperative assessment tool to predict postoperative complications. Despite increasing knowledge and improved technology, a worldwide operational definition of sarcopenia applicable across racial/ethnic groups and populations lack consensus. It is unclear whether a decline in functional capacity results from the loss of muscle mass and/or the qualitative impairment of the muscle tissue. Thus, men and women present trajectories in the decline in skeletal muscle with aging. Men have a gradual decline, while women tend to have a sudden drop in muscle mass and function following menopause.

The current prevalence of sarcopenia in populations varies depending on the definition used, the limitations of past epidemiological and clinical data from small samples, and mixed information from the different measurement techniques employed. It is important to note that these studies used different measures of relative muscle mass, reference groups, and cutpoints, so it is difficult to compare prevalence among various studies.

Thus, a comprehensive approach to sarcopenia requires a multi-modal approach. Bioelectrical Impedance Analysis, dual-energy X-ray absorption,and magnetic resonance imaging have previously been used to measure the Skeletal Muscle Index. However, these three technologies have shortcomings and were therefore unsuitable for the present study.

We studied 165 patients, 20 (12.1%) patients were categorized as having sarcopenia. In the present study, the sarcopenic group was significantly older and had significantly lower PMI, calf muscle circumference, and gait speed than non-sarcopenic group, but other physical parameters such as height, weight, and BMI were not significantly different.

The elderly patients could have more aging-related complications following surgery. However, age was not an independent predictor of postoperative infections in multivariate analysis. The prevalence of PPC in this study was 27.27% (45/165) with 55% (11/20) in sarcopenia group and 23.45% (34/145) in non-sarcopenia group. The patients with sarcopenia had a significantly higher incidence of PPC. In my study population, the presence of respiratory comorbidity, smoking history, anesthesia duration, surgical category, duration of Nasogastric tube placement, and functional dependence was not identified as key risk factors which are in turn consistantly identified risk factors in studies and meta-analyses for PPC development. Skeletal muscle depletion with increasing adipose tissue leads to the synthesizing and secretion of several proinflammatory adipocytokines.

However, sufficient evidence to identify the effect of sarcopenia on outcome is lacking. The distribution of postoperative infectious and non-infectious diseases for 165 patients was as follows: diarrhea, 3 cases (1.82%); paralytic ileus, 11 cases (6.67%); urinary retention, 6 cases (3.64%); wound abscess, 17 cases (10.3%), with slightly more prevalence in sarcopenia group. Hence, It could be hypothesized that sarcopenia reflects the patients' frailty including impaired immune function which leads to the incidence of postoperative complications.

The results of my study suggest that sarcopenia may be a new and independent predictor of pulmonary complications after elective open upper abdominal surgeries. Improved understanding and treatment of sarcopenia would have a dramatic impact on improving the health and quality of life for the elderly, reducing the associated comorbidity and disability, and stabilizing rising health care costs. Identifying patients with preoperative sarcopenia help provide clinicians with useful clinical information to aid treatment decisions. However, continued research is needed to support a consensus operational clinical definition of sarcopenia applicable in clinical management and clinical and epidemiological research across populations. Furthermore, evidence indicates that exercise and nutritional support may improve complications and the prognosis in patients with sarcopenia. Therefore, appropriate perioperative management methods can be adopted, protein supplementation, and other methods that improve the condition of skeletal muscles and prevent postoperative complications. Currently, resistance strength training is the only treatment that affects the muscle aspects of sarcopenia. There are no pharmacological approaches that provide definite evidence in the ability to prevent the decline in physical function and sarcopenia. Current and future pharmacological and clinical trials and epidemiological studies could radically change our therapeutic approach to understanding and treating mobility and disability in elderly.

CONCLUSION

Sarcopenia is a condition that becomes more prevalent with advancing age, as well as with many diseases and exercise deficit disorder. Although there is continuing debate about the optimal application of clinical algorithms, diagnostic thresholds, and imaging techniques.

sarcopenia is increasingly recognized as an independent risk factor for adverse health outcomes. Muscle is routinely included on radiologic examinations, and imaging analysis of sarcopenia as a potential prognostic biomarker deserves further attention. The present study demonstrated that

sarcopenia itself, defined as reduced skeletal muscle mass plus low muscle strength and/or low physical performance, is an independent risk factor for pulmonary complications after elective open upper abdominal surgery. Including a functional aspect to the definition of sarcopenia may result in better prediction of postoperative complications.

However, further studies are needed to determine the value of sarcopenia for assessing long-term outcomes following open upper abdominal surgeries. This was a kind of study to externally validate the Melbourne score for risk prediction in an independent medically defined high-risk population. This observational study has identified several important points to consider in future trials. It is important to also consider that the pre-and peri-operative risk factors only accounted for approximately one-third of the variance in PPC. It is intuitive for the therapist to consider other factors such as adequate analgesia and time to mobilize that may also impact on the risk of PPC development. To my knowledge, no risk prediction model has been developed taking this into consideration, so lot of research still has to be done as a whole.

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