

Impact of psoas muscle area measurement in complex open abdominal aortic aneurysm repair

Impacto de la medición del área del músculo psoas en la reparación de aneurismas de aorta abdominal complejos

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Abstract

Objective: Cross-sectional psoas muscle area (PMA), measured by computed tomography images, is a surrogate of the muscle mass. We aimed to evaluate the impact of PMA and length of stay (LOS) after complex open abdominal aortic aneurysm repair (OAAAR). **Methods:** A retrospective review between January 2013 and January 2017 was conducted. The main outcome was to assess the PMA as a predictor of LOS. Demographics and clinical variables were collected, and Spearman's rank coefficient was used to define the correlation of PMA and LOS. **Results:** A total of 72 patients were studied with a mean age of 72 (standard deviation $\pm$ 10.3) years, and 54 (75%) were males. The median post-operative LOS was 10 (7-14) days; lower PMA was correlated with longer LOS ($R = -0.47$, $p \leq 0.001$). Thirty-six patients (50%) had a PMA $< 17 \text{ cm}^2$, which was associated with greater post-operative 30-day complications ($p = 0.004$). There was no difference in 30-day mortality between patients with PMA $< 17 \text{ cm}^2$ and those with PMA $> 17 \text{ cm}^2$ ($p = 0.147$). **Conclusions:** Lower PMA was associated with longer LOS and a higher rate of 30-day complications; however, no statistically significant difference was found in mortality.

Keywords: Psoas muscle area. Length of stay. Abdominal aortic aneurysm. Open repair. Clinical outcomes.

Resumen

Objetivo: Evaluar el impacto de la medición del área del músculo psoas (AMP) en la estancia hospitalaria (EH) posterior a la reparación abierta de los aneurismas de aorta abdominal (RAAAA) complejos. **Métodos:** Revisión de pacientes que fueron sometidos a RAAAA entre enero de 2013 y enero de 2017. El objetivo principal fue la evaluación de la medición del AMP como predictor de EH. Se documentaron variables demográficas y clínicas, y se utilizó el coeficiente de Spearman para correlacionar el AMP y la EH. **Resultados:** Se incluyeron 72 pacientes con una media de edad de 72 años (DE: 10.3), de los que 54 (75%) eran hombres. La mediana de EH fue de 10 (7-14) días. Un AMP baja se correlacionó con una EH prolongada ($R = -0.47$; $p < 0.001$). Treinta y seis pacientes (50%) tuvieron AMP $< 17 \text{ cm}^2$, y se asoció con mayor tasa de complicaciones a 30 días ($p = 0.004$). No se observaron diferencias en cuanto a mortalidad ($p = 0.147$). **Conclusiones:** Un AMP baja se asoció a una EH más larga y a mayores tasas de complicaciones a 30 días; sin embargo, no hubo diferencia significativa en cuanto a mortalidad.

Palabras clave: Área del músculo psoas. Estancia hospitalaria. Aneurisma de aorta abdominal. Reparación abierta. Resultados clínicos.

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Introduction

The proportion of older adults is expected to increase within the next few years, particularly in countries where the demographic transition is accelerated.¹ By 2050, almost 23% of the total population will be 60 years or older, 3 times greater than what it was in 2010. Regrettably, this has seemed to be accompanied by an increase in chronic diseases.¹ Due to the increased prevalence of arterial hypertension and diabetes, there will also be an increase in the incidence of arterial diseases; therefore, more vascular interventions in the elderly population will be needed. Age-related changes have demonstrated a negative impact on outcomes in the older population, such as increased mortality and complications after abdominal surgery, and some others related just to hospitalization. Some age-related complications, such as delirium, urinary incontinence, pressure ulcers, depression, infection, and decline in functionality, can influence post-operative outcomes.^{2,3} In terms of surgery decision making, the eligibility of older adults has become an important issue, and the need for objective parameters that could help to identify patients at higher risk of post-operative complications and hospitalization length of stay (LOS) is still necessary.⁴

Sarcopenia is a geriatric syndrome characterized by a decline in skeletal muscle mass and decreased strength,⁵ it has been studied in multiple scenarios. It is known to be related to higher mortality and post-operative complications in older adults after abdominal and cardiovascular surgeries.^{2,6,7} There are many ways to identify sarcopenia, and the choice of measurement depends on the patient and the resources that each hospital can access. Psoas muscle area (PMA) measured by computed tomography (CT) has been used to identify sarcopenia in pre-operative patients.⁵ Some authors have found PMA association with adverse outcomes in cardiovascular surgeries.⁸ This study aims to determine the association of PMA and LOS after open aortic aneurysm repair, and whether PMA has an impact on post-operative complications in these patients.

Methods

We performed a retrospective perioperative CT scan analysis of patients who underwent open abdominal aortic aneurysm repair (OAAAR) at our third-level referral center in Mexico City. The PMA was measured

at the level of the L3 vertebrae; this was defined as the CT slice including the most inferior portion of the L3 vertebral body. Data of patients with an OAAAR treated between January 2013 and January 2017 were collected. Patients with an acute rupture were excluded because of higher morbidity and mortality. Demographic characteristics, complications, and outcomes were obtained from medical records.

Patients were divided into two groups to compare LOS, we defined the cut-off point, as the median of days after surgery in all patients. As a secondary outcome, we divided the patients by their mean PMA into two groups for comparison. This research project follows the regulations of an institution and the generally accepted guidelines governing this work. For this study, informed consent was not required.

PMA determination

CT scans were performed before all procedures for clinical evaluation, and Osirix MC (Pixmeo SARL, Geneva, Switzerland) multiplanar reformatting software was used to measure the right and left PMA in an axial plane. (Fig. 1) The L3 level was selected in accordance with the European Working Group on Sarcopenia in Older Adults recommendations for the diagnosis of sarcopenia.⁵ Interobserver mean differences were assessed in two observers researches by measuring the PMA in 20 randomized patients. PMA values were represented as continuous variables with a mean PMA in the study group.

Statistical analysis

Categorical variables are shown as frequencies and continuous variables as mean $\pm$ standard deviation or as median and interquartile range. Spearman's rank correlation coefficient was used to assess the linear correlation between PMA and LOS. Distribution of categorical variables was compared using the χ^2 test. Continuous variables were compared with a univariate test, and statistical significance was considered at a two-sided $p < 0.05$. Data were collected and analyzed using the Statistical Package for the Social Sciences (IBM SPSS, version 22, IBM Corp., NY, USA).

Results

A total of 72 patients were included in this study, with a mean age of 72 ± 10 years, and 75% (54 patients)

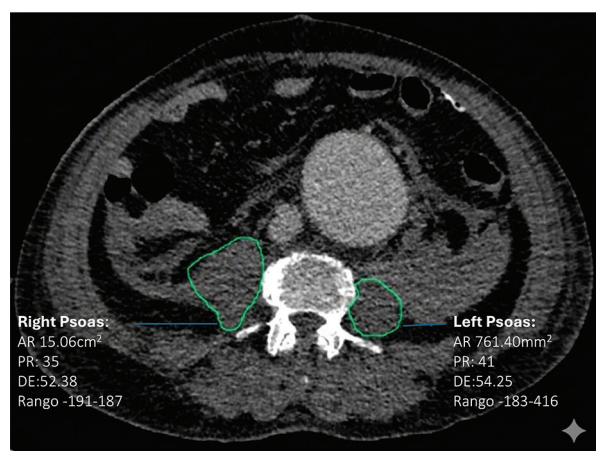


Figure 1. Cross-sectional view of the computed tomography with the Psoas muscle area measurement in a patient with an abdominal aortic aneurysm.

were male. Regarding comorbidity, 66% had hypertension, 20% diabetes, and 86% had a history of smoking. The median abdominal aortic aneurysm (AAA) diameter in centimeters was 64 (55-74) (Table 1).

The mean interobserver PMA difference found (one radiology fellow and one vascular surgeon fellow) in 20 patients was 0.4 cm² (95% confidence interval [CI] -0.9-1.2 cm²), and the mean interobserver difference was 0.5 cm² (95% CI -1.3-2.1 cm²). The correlation obtained by the Spearman test between PMA and post-operative LOS was negative ($R = -0.47$, $p < 0.001$), supporting the fact that patients with lower PMA were more likely to have longer LOS after surgery (Fig. 2).

The median LOS for the 72 patients included in the study was 10 (7-14) days, after dividing groups by their median, the first group included 42 patients (58.3%) who stayed < 10 days after OAAAR, with a median age at surgery of 73 (68-78) years, 33 patients (79%) were males, with median AAA diameter of 65 (56-75) cm and a median PMA of 19 (14-23) cm². After comparing the PMA between groups, those patients who stayed more than 10 days after surgery had a smaller PMA compared to those who stayed < 10 days - 14 (11-19) versus 19 (14-23) cm², $p = 0.004$ (Table 2).

As a secondary outcome, 30-day complications were assessed using PMA for the comparison between groups. The cut point used to separate groups was the mean PMA obtained in the 72 patients (17 cm²) (Table 3). We observed that complications after 30 days were present in 71% (26 patients) in the < 17 cm² PMA group compared to 39% in patients with PMA > 17 cm² ($p = 0.004$) (Table 3). None of the complications required surgery intervention. The most

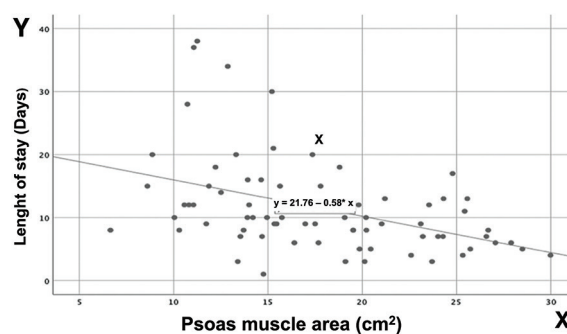


Figure 2. Spearman correlation of length of stay and psoas muscle area. $R = -0.47$ ($p < 0.001$).

Table 1. Demographic and clinical characteristics of the study population

Characteristics	n = 72
Age (years)	72 ± 10
Sex male, n (%)	54 (75)
Diabetes, n (%)	15 (20)
Hypertension, n (%)	48 (66)
CAD, n (%)	12 (16)
Chronic kidney insufficiency, n (%)	15 (20)
Smoke, n (%)	62 (86)
Height (cm)	163 (153-171)
Weight (kg)	67 ± 13
Aortic aneurysm diameter (cm)	64 (55-74)
Creatinine (mg/dL)	1.08 (0.8-1.3)
Albumin level g/dL	3.7 ± 0.66
Psoas muscle area (cm ²)	17 ± 5.8
LOS (days)	10 (7-14)
30-day complication	40 (55)

LOS: length of stay; CAD: coronary artery disease.

common complications that we found were: respiratory complications (30%) as pulmonary embolism and pneumonia; cardiac complications (25%) as arrhythmias, myocardial infarction, and cardiac failure; renal complications (15%) as acute renal failure, urinary retention, and urinary tract infections; and other complications (30%) such as incisional hernia, small bowel obstruction or wound infection. There was no significant difference in death between groups ($p = 0.147$); however, those patients with PMA < 17 cm² had longer LOS 12 (9-17) versus 8 (5-11) days ($p = 0.001$).

Table 2. Comparison of patients divided by length of stay in the post-operative

Characteristics	LOS < 10d n = 42	LOS > 10d n = 30	p
Age (years)	73 (68-78)	74 (67-80)	0.468
Sex male, n (%)	33 (79)	21 (70)	0.408
Diabetes, n (%)	9 (21)	6 (20)	0.888
Hypertension, n (%)	29 (69)	19 (63)	0.612
CAD (%)	7 (17)	5 (17)	1.0
Chronic renal failure, n (%)	8 (19)	7 (23)	0.659
Smoke, n (%)	38 (90)	24 (80)	0.205
Height (cm)	161 (150-172)	165 (156-170)	0.441
Weight (kg)	68 ± 13	65 ± 13	0.392
Aortic aneurysm diameter (cm)	65 (56-75)	61 (55-72)	0.355
Creatinine (mg/dL)	1.08 (0.8-1.3)	1.08 (0.8-1.5)	0.918
Albumin g/dL	3.8 ± 0.63	3.5 ± 0.68	0.065
Psoas muscle area (cm ²)	19 (14-23)	14 (11-19)	0.004*

*p < 0.05.

LOS: length of stay; CAD: coronary artery disease.

Table 3. Comparison of patients divided by Psoas muscle area in the post-operative

Characteristics	PMA < 17cm ² (n = 36)	PMA > 17cm ² (n = 36)	p
Age (years)	75 (69-81)	71 (66-77)	0.32
Sex male, n (%)	20 (56)	34 (94)	0.000*
Diabetes, n (%)	8 (22)	7 (19)	0.772
Hypertension, n (%)	22 (61)	26 (72)	0.317
CAD, n (%)	6 (17)	6 (17)	1.0
Chronic renal failure, n (%)	6 (17)	9 (25)	0.384
Smoke, n (%)	28 (78)	34 (94)	0.041*
Height (cm)	161 (152-165)	168 (158-175)	0.062
Weight (kg)	61 ± 11.5	73 ± 12	0.000*
Aortic aneurysm diameter (cm)	67 (55-80)	62 (57-71)	0.460
Creatinine (mg/dl)	1.0 (0.8-1.3)	1.1 (0.8-1.4)	0.288
Albumin g/dL	3.6 ± 0.7	3.8 ± 0.6	0.214
Mortality	10 (28)	5 (14)	0.147
30-day complications	26 (71)	14 (39)	0.004*
LOS	12 (9-17)	8 (5-11)	0.001*

*p < 0.05.

PMA: psoas muscle area; CAD: coronary artery disease; LOS: length of stay.

Discussion

Once an aneurysm in the abdominal aorta has been diagnosed and after it reaches the threshold for elective repair, the risk for post-operative complications and death must be assessed against the risk of rupture.⁹ Consequently, many prediction models have been described to estimate morbidity and mortality; however, many of these include poor suitability variables for OAAAR.^{10,11} Frailty is a geriatric syndrome where low muscle mass and strength play an important role, contributing to a diminished homeostatic capability and leading patients to a higher vulnerability to stressors such as surgical interventions and post-operative time.¹¹⁻¹⁶ This syndrome becomes more prevalent with increasing age, and sarcopenia, which is defined as a loss of muscle mass and strength, is an important characteristic of the latter.^{5,17} In addition, as it has been reported as an easy component to measure by imaging techniques such as CT⁹ and due to the relevant association that sarcopenia has with post-operative outcomes such as LOS and major adverse complications, it has gained interest by many authors in the surgical field.^{12,16,18-22}

Nowadays, there is growing evidence that PMA can predict negative post-operative outcomes such as an increasing patient morbidity and mortality.^{12,16,19-22} In regard to the proposed threshold to define low PMA in these patients, there is no universally accepted cutoff point, since some authors have chosen to stratify their patients in percentiles^{7,14,16,18} and others have chosen a random cut point.^{12,20,23} As no threshold value for sarcopenia exists currently in the literature regarding PMA,^{21,22} we decided to stratify our post-operative patients into those above the mean PMA obtained from patients' CT scans reviewed (mean = 17 cm²). Using our proposed threshold, 36 patients (50%) were defined as having a low PMA, showing a statistically significant association (p = 0.004) with greater post-operative 30-days complications as well as an increased LOS (> 10 days) (p = 0.001) identifying PMA as a radiologic biomarker of frailty, helping in the prediction of post-operative morbidity in patients considered for complex abdominal aortic aneurysm open repair.

Clinical research has been growing, focusing on the association of a low PMA with an increased post-operative morbidity and mortality, as stated in a systematic review by Antoniou and colleagues²⁴ confirming the relevance of low skeletal muscle mass as a prognostic factor for survival. LOS then becomes a

crucial post-operative outcome to consider for a physician when deciding on the best course of treatment for patients, as an increased LOS leads to higher costs for patients and the healthcare system. We found in the present study that a lower PMA was significantly associated with longer LOS, which supports the evidence from previous studies. Our results are in concordance with those reported by Zuckerman et al.,¹² who reported an increased LOS in patients with a lower PMA.

Limitations of the present study are those inherent in the retrospective nature of our work and possible selection bias.

Conclusion

Patients with the lower PMA (below 17 cm²) were associated with longer LOS and a higher rate of 30-day complications. However, no statistically significant difference was found in mortality. PMA measurement might assist as a postoperative predictor of LOS in major vascular surgery.

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Conflicts of interest

The authors declare no conflicts of interest.

Ethical considerations

Protection of human subjects and animals. The authors declare that the procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation and with the World Medical Association and the Declaration of Helsinki. The procedures were authorized by the Institutional Ethics Committee.

Confidentiality, informed consent, and ethical approval. The authors have followed their institution's confidentiality protocols, obtained informed consent from all patients, and secured approval from the Ethics Committee. SAGER guidelines have been followed as applicable to the nature of the study.

Declaration on the use of artificial intelligence. The authors declare that no generative artificial intelligence was used in the writing or creation of the content of this manuscript.

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