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PSOAS MUSCLE AREA DERIVED FROM PREOPERATIVE MAGNETIC RESONANCE IMAGING AS AN INDICATOR OF SARCOPENIA AND PATIENT PROGNOSIS IN PATIENTS UNDERGOING INVASIVE TREATMENT FOR PERIPHERAL ARTERIAL DISEASE

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Alaraajojen tukkivassa valtimotaudissa alaraajoihin johtavat valtimot ahtautuvat tai tukkeutuvat, mikä aiheuttaa hapenpuutteen kyseisen valtimon suonittamalle alueelle. Tukkiva valtimotauti voi olla oireeton, mutta se saattaa myös ilmetä katkokävelynä tai kroonisena raajaa uhkaavana iskemiana. Klaudikaatio eli katkokävely johtuu alaraajan rasituksenaikaista hapenpuutetta seuraavasta kivusta. Kipu väistyy levossa ja oireet helpottavat alle 10 minuutissa. Yöllinen leposärky tai iskeeminen kudosvaurio, haava tai kuolio, ovat merkkejä kriittisestä iskemiasta.

Aikaisemmat tutkimukset osoittavat, että alaraajojen tukkivan valtimotaudin vaikeusaste on yhteydessä sydäntapahtumiin ja -kuolleisuuteen. Potilaista 40-60 % kuolee sepelvaltimotautiin, 10-20 % aivovaltimotautiin ja noin 10 % muuhun verisuonitapahtumaan. Potilaiden, joilla on krooninen raajaa uhkaava iskemia, kuolleisuus on 20-25 % ensimmäisen vuoden aikana. Myös amputaation riski on merkittävä. Uusien ennustetekijöiden kartoittaminen on tärkeää hoitotoimenpiteiden kohdentamiseksi ja riskitekijöiden hoidon optimoimiseksi.

Sarkopenia tarkoittaa lihasmassan ja -voiman vähenemistä. Sen esiintyvyys lisääntyy iän myötä. Useat tekijät, kuten perimä, hormonit, ravintotekijät, useat sairaudet sekä vähentynyt fyysinen aktiivisuus vaikuttavat sarkopenian kehittymiseen. Lihasmassaa voidaan mitata tietokonetomografian (CT) tai magneettikuvauksen (MRI) avulla. Psoas-lihasten poikkipinta-alaa on käytetty sarkopenian mittarina. Psoas-lihakset sijaitsevat vatsaontelon takaseinämässä ja niiden tehtävänä on lonkan koukistus ja ulkokierto sekä ylävartalon sivutaivutus. Psoas majorin lähtökohdat sijaitsevat nikamissa T12-L4 ja psoas minorin nikamissa L1-L5. Lihasten yhteinen kiinnityskohta on reisiluun trochanter minorissa.

Psoas-lihasten pinta-alan on aikaisemmissa tutkimuksissa voitu osoittaa olevan yhteydessä potilaiden kuolleisuuteen sydän- ja verisuonitoimenpiteiden jälkeen. Aikaisemmissa tutkimuksissa lihasparametrien arvioiminen on perustunut pitkälti CT-tutkimuksiin. Kuitenkin useimmiten kajoaviin alaraajojen valtimotoimenpiteisiin tulevista potilaista otetaan ennemmin MRI-kuvat, sillä ne ovat kustannustehokkaita ja potilaiden kannalta edullisia. MRI-kuvien avulla voidaan tutkia uusia mahdollisia ennustetekijöitä ilman, että potilaalle aiheutuu vaivaa tai lisäkustannuksia. MRI-kuvista mitattujen psoas-parametrien yhteyttä potilaiden kuolleisuuteen ei parhaan tietomme mukaan ole tutkittu alaraajaiskemiapotilailla. Hypoteesimme oli, että sarkopenia ja psoas-lihasten pinta-alan pieneneminen lisäävät kuolleisuutta alaraajaiskemiapotilailla. Mikäli hypoteesimme osoittautuu paikkansa pitäväksi, magneettikuvaus voisi toimia työkaluna hoitotoimenpiteiden kohdentamisessa.

Tutkimus oli retrospektiivinen rekisteritutkimus. Potilasaineisto kerättiin Tampereen yliopistollisen sairaalan potilastietokannasta vuosilta 2010-2020. Tutkimukseen sisällytettiin invasiiviset verisuonikirurgiset toimenpiteet: endovaskulaariset, avokirurgiset ja hybridi-toimenpiteet. Elektiiviset, kiireelliset ja päivystykselliset toimenpiteet huomioitiin. Tutkimus sisälsi potilaita, joilla oli joko klaudikaatiotasoinen iskemia tai krooninen raajaa uhkaava iskemia. Hyväksymiskriteerinä oli, että potilaasta oli otettu MRI-kuva korkeintaan kuusi kuukautta ennen toimenpidettä. Jos potilaalle oli tehty useampia toimenpiteitä, vain niistä ensimmäinen otettiin mukaan tutkimukseen. Psoas-lihasten pinta-ala mitattiin L4-nikaman yläpinnan tasolta piirtämällä sen ääriviivat. Lopullisesta aineistosta jäi pois potilaita, joiden MRI-kuvat olivat liian epäselviä niiden tulkitsemiseksi.

Alustava aineisto koostui yhteensä 1359 potilaasta, mutta aineisto rajautui 899 potilaaseen. Seuranta-ajan päättymisen päivämäärä oli 17.6.2021. Potilaskertomuksista etsittiin tietoja muun muassa potilaan iästä, BMI:stä, verenpainetaudista, dyslipidemiasta, diabeteksesta, sepelvaltimotaudista, tupakoinnista,

aikaisemmista aivoverenkiertohäiriöistä, keuhkosairauksista, munuaisten vajaatoiminnasta sekä aikaisemmista toimenpiteistä. Myös mahdolliset amputaatiot, lääkitys ja potilaan taudinkuva huomioitiin.

Potilaista 569 (63,3 %) oli miehiä ja 330 (36,7 %) oli naisia. Psoas-lihasten pinta-alojen keskiarvo oli suurempi miehillä (6,88 cm2) kuin naisilla (5,36 cm2). Miehistä 66,1 %:lla oli sarkopenia ja naisista 43,3 %:lla. Monimuuttuja-analyysi osoitti, että psoas-lihasten pinta-alalla oli tilastollisesti merkittävä yhteys kuolleisuuteen naisilla ($p > 0,001$), mutta miehillä tätä yhteyttä ei voitu yhtä merkittävästi osoittaa ($p = 0,656$).

Tutkimuksemme merkittävimpänä vahvuutena oli laaja potilasaineisto. Kuitenkin on mahdollista, että joitakin potilaita on alustavan aineiston keruun aikana jäänyt huomioimatta. On mahdollista, että inhimillisiä virheitä on tapahtunut missä tahansa tutkimuksen vaiheessa. Tutkimuksemme osoittaa, että psoas-lihasten pinta-alan mittaaminen MRI-kuvista voisi olla varteenotettava ennustetekijä kliiniseen käyttöön. Tämä on linjassa aiempien aiheesta tehtyjen tutkimusten kanssa. Lisää tutkimuksia tarvitaan löydösten varmistamiseksi.

Avainsanat: psoas, MRI, sarkopenia, alaraajojen tukkiva valtimotauti

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CONTENTS

1 INTRODUCTION

Peripheral arterial disease (PAD) is a condition in which the narrowing or blockage of the arteries causes decreased blood flow to the distal extremities. It is caused by atherosclerosis, which occurs when fatty plaque builds up in the wall of the artery.[1] PAD is more common in the blood vessels of the legs than of the arms. Many people with PAD have no symptoms, but reduced blood flow to the legs and feet can cause claudication, pain in the muscles of the leg. The location of the pain is dependent on the location of the clogged or narrowed artery. Most often the pain occurs in calves, thighs or buttocks. This pain develops during activity, such as walking, and forces the patient to stop. Claudication is relieved by resting and the symptoms pass in less than 10 minutes.[2] PAD is the main cause of chronic limb-threatening ischemia (CLTI). CLTI manifests as chronic ischemic rest pain, ischemic skin lesions or gangrene.[3]

The severity of the PAD is related to the increased risk of cardiovascular events and mortality. Among patients with PAD, excluding those with CLTI, the 5-, 10- and 15-year morbidity and mortality rates are approximately 30 %, 50 % and 70 %, respectively. Coronary artery disease is the most common cause of death accounting for 40 % to 60 % of deaths, while cerebral artery disease causes 10 % to 20 % of deaths and other vascular events cause approximately 10 % of deaths. The mortality rate for patients with chronic CLTI is 20-25 % in the first year after presentation. There is also a high risk of amputation.[4] Identifying new prognostic factors is crucial for better targeting treatment and optimizing risk factor management.

Sarcopenia is defined as progressive loss of skeletal muscle mass and function. The incidence of sarcopenia increases with age. Several factors, such as genetics, hormones, nutrition, a variety of diseases and lack of muscle use, affect the progression of sarcopenia.[5] Different techniques, including computed tomography (CT) or magnetic resonance imaging (MRI), can be used to assess muscle mass.

Cross-sectional area of psoas muscle has been used as an indicator of sarcopenia. The psoas muscle is composed of psoas major and psoas minor, and is located in the posterior wall of the

abdominal cavity. The function of the psoas muscle is flexion and lateral rotation of the thigh, flexion and lateral rotation of the trunk. In addition, it has a postural function. The psoas muscle originates from the lateral surfaces of the T12 corpus vertebrae, the L1-L5 vertebrae and the associated intervertebral discs. The site of insertion is the lesser trochanter of the femur.[6]

Psoas muscle area (PMA), as an indicator of sarcopenia, has previously shown to independently predict all-cause mortality after general and vascular surgery[7], endovascular and open aortic aneurysm repair[8,9,10,11] and transcatheter aortic valve implantation[12,13,14]. One study showed that the 3-year cardiovascular event-free survival rates were 43.1 % and 91.2 % for sarcopenic and non-sarcopenic patients, respectively[15] and in another study a 5-year survival rate for patients with sarcopenia was 23.5 % and without sarcopenia 77.5 %[16]. Previous research has mainly used CT scans to assess muscle mass. However, in most cases PAD patients rather undergo preoperative MRI scans. MRI is cost-effective and beneficial for the patient in case further identification of the prognostic factors is needed. At least one study has evaluated the use of MRI to measure psoas muscle volume. The results showed the reliability and repeatability of the MRI.[17]

To the best of our knowledge, this is the first study to evaluate the connection between the MRI-derived psoas muscle area and mortality in PAD patients. The primary objective of this study is to assess the connection between the MRI-derived PMA and the long-term prognosis of patients with claudication or CLTI after surgical or endovascular revascularization (angioplasty, endarterectomy, stenting or bypass). We hypothesized that the small PMA is a risk factor for high mortality.

2 METHODS

The study was a retrospective registry study. The data was retrieved from the Tampere University Hospital patient registry and the patient registry of Tampere University Hospital department of radiology between years 2010 and 2020. Invasive vascular surgeries such as open, endovascular and hybrid procedures were all accepted to the study. Elective, urgent and emergency procedures were included. The cohort included patients suffering from claudication as well as chronic limb-threatening ischemia. A patient was accepted to the study if they had a MRI scan prior to the procedure and the scan was taken a maximum of six months prior to the procedure date. A patient was accepted to the data only once, meaning that if the patient had multiple procedures during the years, the first procedure was significant. A patient was also rejected from the data if the quality of the MRI scan was too poor to measure the psoas muscle.

The surface area of the psoas muscle was measured from the MR images by hand in the PACS system of TAYS radiological patient registry (Sectra Workstation IDS7 23.1.10.4570 (x64), Sectra AB). Scans were converted to the three dimensional MPR view. Both thoracic and lumbar scans were accepted, as long as the L4 level of the spine was shown, and the psoas muscles were fully visible so the measuring could be properly executed. All psoas surface areas (PSA) were measured from the lower surface of the L4 level of the spine.

A total of 1359 patients who underwent a vascular procedure were found in the registry between January 1st of 2010 and November 27th of 2020. Finally, 899 patients fulfilled the inclusion criteria listed above and were included in the study. The study endpoint was set on 17.6.2021, when the final exitus dates were retrieved from the registry and the follow-up of the patients finished.

Risk factors such as age, body mass index, hypertension, diabetes, dyslipidemia, coronary artery disease, smoking (never, former, active), neurological events such as TIA or infarction, pulmonary diseases, renal insufficiency and previous vascular surgeries were then gathered from the medical history of the patients. Also data such as possible major amputations, medication, Fontaine

classification, WiFi grade, possible lower limb wounds and infections, use of aids and possible later vascular procedures were gathered. All data was retrieved from the medical case summary of the Uranus 8.4.6.35.3 CGI Suomi Oy, OMNI360 Kertomus 1.0.0.03E (2012)-system of Tampere University Hospital patient registry.

The Fontaine classification describes four stages of peripheral artery disease: stage I asymptomatic or incomplete blood vessel obstruction, stage II mild claudication in limb (IIA claudication at a distance of over 200 meters, IIB claudication at a distance of under 200 meters), stage III rest pain and stage IV necrosis and/or gangrene of the limb. The classification system is based on clinical symptoms.

The WIfI classification stands for wound (W), ischemia (I) and foot infection (fI). These three factors have a significant impact on lower limb amputations and are in relation to vascular health. The scale varies from 0-3. In our patient data the WIfI scale was found in both ABI and toe pressure (TP) measurements, from which the toe pressure was chosen. If only one measurement (ABI or TP) was mentioned, that measurement was accepted.

Statistical analyses were executed via IBM SPSS Statistics Data Editor 26 EN 64bit v100 edition for Windows. The risk factors mentioned above were analyzed measuring the procentual predominance of the factors in our patient data. Minimum, maximum, mean and median were gathered. The risk factor parameters were divided between men and women patients. The overall survival after the follow-up was analyzed with the univariable Cox regression analysis. If the result of the parameter was $p < 0.1$, the parameter was accepted for multivariable analysis. Multivariable Cox regression analyses were then performed. The renal factor and the BMI factor were abandoned, as they confused the results of the analysis. If the result of a parameter was $p < 0.05$, the parameter was independently significant in relation to mortality. In addition, the psoas muscle area of women and men were compared using the Mann-Whitney U method. Smoking factor was analyzed in relation to the age factor. Histograms were drawn from the survival function.

Men and women were also categorized whether their psoas muscle area indicated they are sarcopenic. The PSA's were measured (cm2), summed, and this value was divided by two to receive the mean value of a single psoas muscle of a patient. Histograms of the values were drawn. The limit value of sarcopenia was set according to former research data to 8.5 cm^2 for men and 5.0 cm^2 for women[18].

2.1 Ethical viewpoints

The study was a retrospective study where no additional or invasive procedures were performed on the patients. Ethics approval of the ethics committee is not required. The study was executed with the ethical principles of the Declaration of Helsinki and was approved by the dean of the Tampere University and by the Pirkanmaa Hospital District Science Center. All gathered data was treated with high information security.

3 RESULTS

The study patient's baseline, characteristics, symptom severity and operation types as well as urgencies are presented in Table I, and values are presented separately for men and women. The number of patients included in the study was 899, of which 569 (63.3 %) were men and 330 (36.7 %) were women. The median age at the time of the procedure was 70.00 and interquartile ratio was 13 for all patients. Height, weight or BMI of the patient was found in 523 patient's records, most often in the new patient registration forms that patients have filled in themselves.

Table I. Patient risk factors

All patients n = 899
Men n = 569 (63.3 %)
Women n = 330 (36.7 %)

Risk factor	**All patients**	**Men**	**Women**
Age	Median 70.00 IQR 13	Median 68.00 IQR 12	Median 73.00 IQR 13
BMI (kg/m^2) All patients n = 523 Men n = 340 Women n = 183	Median 26.57 IQR 6.30	Median 26.90 IQR 5.87	Median 25.56 IQR 6.86
BMI groups (kg/m^2) BMI < 25 n = 201 (men 117, women 84)	BMI < 25 Median 22.53 IQR 3.13 BMI 25-30	Median 22.91 IQR 2.73	Median 22.03 IQR 3.62

BMI 25-30 n = 197 (men 140, women 57) BMI > 30 n = 124 (men 83, women 41)	Median 27.31 IQR 2.02 BMI > 30 Median 32.13 IQR 4.16	Median 27.24 IQR 2.25 Median 31.60 IQR 3.67	Median 27.31 IQR 1.73 Median 33.09 IQR 5.96
Hypertension (%)	79.9	79.1	81.2
Diabetes mellitus (%)	36.7	40.1	30.9
Dyslipidemia (%)	64.7	65.0	64.2
CAD (%)	33.5	34.6	31.5
Stroke/TIA (%)	15.7	16.7	13.9
Pulmonary disease (%)	22.7	23.6	21.2
Renal insufficiency (%)	6.9	8.3	4.5
Smoking (%) - Never - Previous - Active	 Never 19.9 Previous 42.4 Active 37.7	 Never 11.2 Previous 49.2 Active 39.5	 Never 34.8 Previous 30.6 Active 34.5
Previous vascular intervention (%)	30.3	33.9	23.9
Fontaine classification (%)	I 0.2 IIa 11.9 IIb 48.7 III 24.9 IV 14.2	I 0.2 IIa 15.5 IIb 49.9 III 20.6 IV 13.9	I 0.3 IIa 5.8 IIb 46.7 III 32.4 IV 14.8
Wifi class (Ischemic grade from 0 to 3) (%)	0 37.8 1 23.7 2 15.1	0 41.3 1 22.1 2 14.4	0 31.2 1 26.4 2 16.4

	3 18.2 Missing information 5.3	3 16.7 Missing information 5.4	3 20.9 Missing information 5.2
Operation type (%) - Open surgery - Endovascular - Hybrid	Open surgery 38.9 Endovascular 47.6 Hybrid 13.5	Open surgery 40.4 Endovascular 45.0 Hybrid 14.6	Open surgery 46.4 Endovascular 52.1 Hybrid 11.5
Urgency of procedure (%)	Elective 62.2 Urgent 34.7 Emergency 3.1	Elective 64.9 Urgent 32.3 Emergency 2.8	Elective 57.6 Urgent 38.8 Emergency 3.6

Table II presents the surface area measurement information of the psoas muscles for both men and women separately. The right and left psoas muscle information are shown, in addition to the values of the average psoas muscle area.

A significant proportion of the patients were sarcopenic. The survival function of sarcopenia is demonstrated in Figure I. The sarcopenia prevalence for men was 66.1% and for women 43.3%. The psoas muscle surface areas were larger on men (mean 6.88 cm2) than in women (mean 5.36 cm2). Distribution of the psoas muscle area for men and women are presented in histograms of Figure II and Figure III.

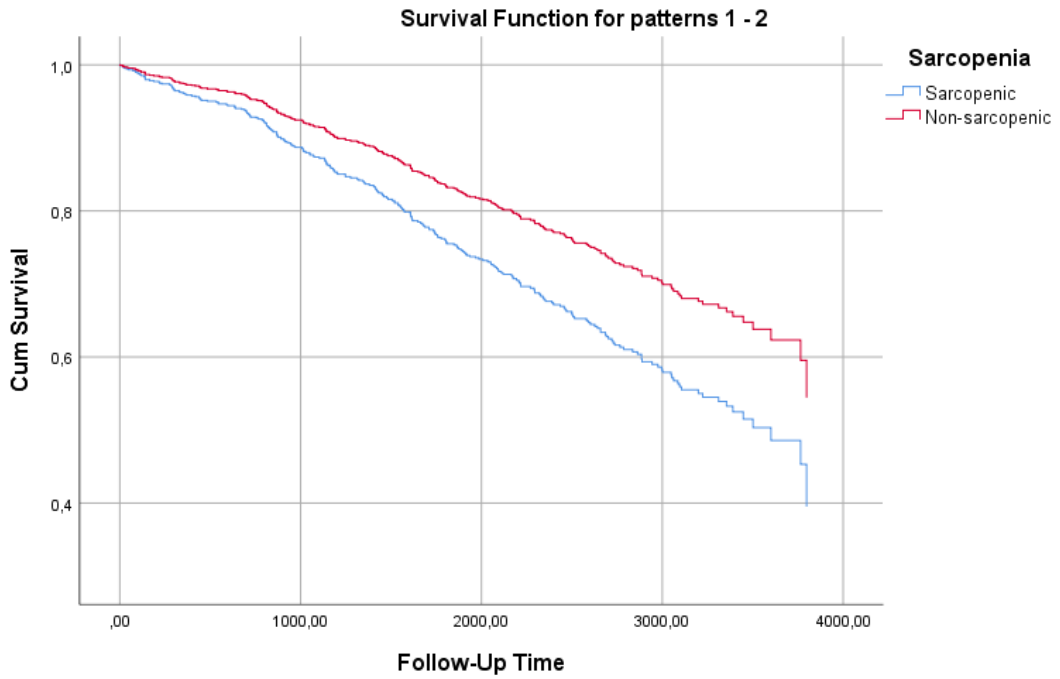

Figure I. The survival function of sarcopenia in relation to time

The average psoas muscle area of women and men were compared using the Mann-Whitney U test, which showed that there was a significant difference ($p < 0.001$).

Multivariable analysis of the surface areas showed that the PSA was a factor that increased the risk of mortality for women ($p < 0.001$), but for men this factor's statistical significance was lost ($p = 0.656$), respectively.

Table II. Surface areas of the psoas muscles

All patients	**Men**	**Women**
Right psoas muscle (cm2)	Mean 7.62 Median 7.42 Minimum 2.48 Maximum 15.16 IQR 3.04	Mean 5.28 Median 5.26 Minimum 1.56 Maximum 12.32 IQR 1.87

Left psoas muscle (cm2)	Mean 7.88 Median 7.71 Minimum 2.70 Maximum 17.03 IQR 2.85	Mean 5.45 Median 5.21 Minimum 1.61 Maximum 12.42 IQR 1.84
Average psoas muscle (cm2)	Mean 7.76 Median 7.58 Minimum 2.59 Maximum 15.05 IQR 2.90	Mean 5.36 Median 5.27 Minimum 1.94 Maximum 12.37 IQR 1.60

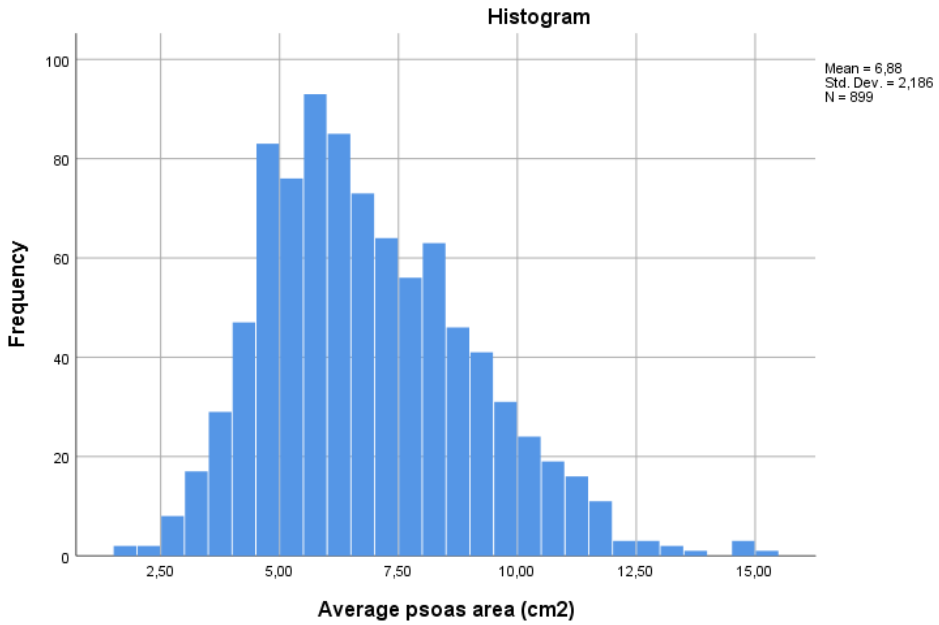

Figure II. The average psoas muscle area of men

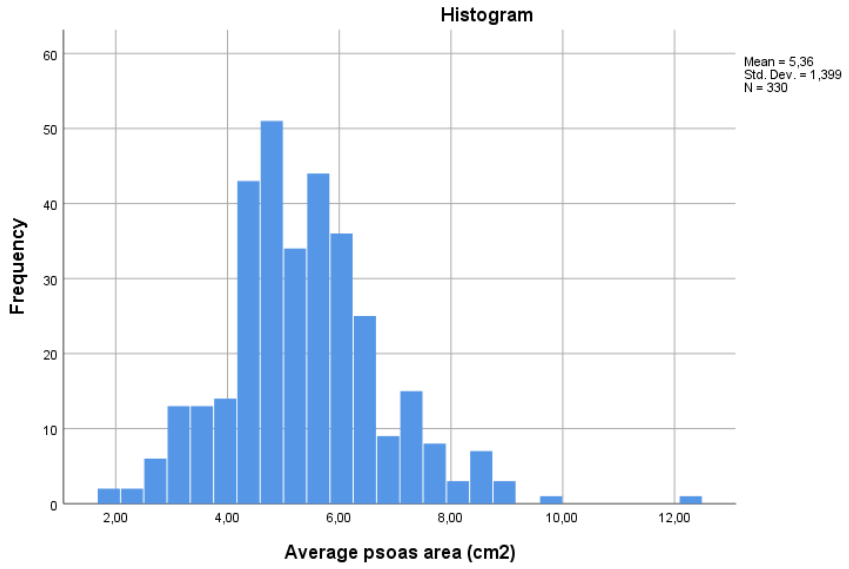

Figure III. The average psoas muscle area of women

Table III presents the mortalities and the overall survival distribution of the patients during our study.

Table III. Patient mortalities

Mortality	**N of events**	**% of mortalities of all patients**
1 month	4	0.4
3 month	9	1
6 month	19	2.1
During the entire follow-up	259	28.8

Table IV shows the Univariable Cox regressions analyses of overall survival. Table V shows the Multivariable Cox regression analyses of overall survival for men, and Table VI presents these values to women.

Table IV. Univariable Cox regression analyses of overall survival

Factor	**Sig = p-value**	**Exp(B) = Hr**	**95% CI**
Age	< 0.001	1.057	Lower: 1.043 Upper: 1.072
BMI	0.001	0.933	Lower: 0.897 Upper: 0.970
BMI < 25	0.127	0.923	Lower: 0.833 Upper: 1.023
BMI 25-30	0.721	1.047	Lower: 0.814 Upper 1.346
BMI > 30	0.239	0.916	Lower: 0.792 Upper: 1.060
Hypertension	0.954	1.009	Lower: 0.741 Upper: 1.374
Diabetes mellitus	0.060	1.275	Lower: 0.990 Upper: 1.642
Dyslipidemia	0.004	0.695	Lower: 0.542 Upper: 0.893
CAD	< 0.001	1.563	Lower: 1.219 Upper: 2.002
Neurological	< 0.001	1.803	Lower: 1.348 Upper: 2.411
Pulmonal	< 0.001	1.874	Lower: 1.433 Upper: 2.452
Renal	< 0.001	3.343	Lower: 2.364 Upper: 4.729
Former	0.120	1.228	Lower: 0.948

reconstruction			Upper: 1.590
Average psoas muscle surface area (cm2)	0.003	0.917	Lower: 0.866 Upper: 0.970
Z scored average psoas muscle surface area (cm2)	0.003	0.827	L: 0.730 U: 0.936
Smoking - Never - Previous - Active	 < 0.001 0.010 < 0.001	 - 1.576 2.812	 - L: 1.116 U: 2.226 L: 1.925 U: 4.106

Table V. Multivariable Cox regression analyses of overall survival for men

Factor	**Sig = p-value**	**Exp(B) = Hr**	**95% CI**
Age	< 0.001	1.062	L: 1.042 U: 1.083
Diabetes mellitus	0.063	1.345	L: 0.984 U: 1.837
Dyslipidemia	0.019	0.673	L: 0.484 U: 0.938
CAD	0.077	1.344	L: 0.969 U: 1.864
Neurological	0.005	1.684	L: 1.171 U: 2.422
Pulmonal	< 0.001	2.220	L: 1.590 U: 3.099
Former or active smoking	0.262	1.328	L: 0.809 U: 2.182
Average psoas muscle surface area for men (cm2)	0.681	0.983	L: 0.908 U: 1.065

Table VI. Multivariable Cox regression analyses of overall survival for women

Factor	Sig = p-value	Exp(B) = Hr	95% CI
Age	< 0.001	1.067	L: 1.036 U: 1.098
Diabetes mellitus	0.235	1.319	L: 0.836 U: 2.080
Dyslipidemia	0.001	0.480	L: 0.306 U: 0.754
CAD	0.078	1.509	L: 0.954 U: 2.387
Neurological	0.015	1.926	L: 1.135 U: 3.271
Pulmonal	0.777	0.926	L: 0.546 U: 1.571
Former or active smoking	0.061	1.621	L: 0.977 U: 2.687
Average psoas muscle surface area for women (cm2)	0.002	0.763	L: 0.644 U: 0.902

4 DISCUSSION

To our knowledge, this is the first study to assess the connection between MRI-derived psoas muscle area and overall survival of the patient. This study shows that PMA is independently associated with survival. The connection was shown especially in women.

The favorable association of dyslipidemia with mortality can be explained by the fact that the patients diagnosed with dyslipidemia, for example hypercholesterolemia, are often treated with statins that have a pleiotropic effect on mortality. Statins have a paradoxical protecting covering effect.

The presence of neurological risk factor indicates presence of polyvascular disease, i.e. disease affecting at least peripheral arteries and cerebrovascular bed. The association of this factor with

impaired survival can be explained by presence of polyvascular disease which has previously been shown to have negative effect on prognosis. The association of pulmonary risk factor (asthma/COPD) with impaired survival can be easily explained by their association with smoking .

The renal factor of the univariable analysis represented as a highly significant factor. This however, was a factor that distorted the other values in the multivariable analysis in a false manner. This was due to the fact that data on renal risk factor was seldom found in patient record, even though the majority of elderly patients most likely had renal insufficiency of a certain degree.

BMI behaved in a manner differing from the general population. This can be explained by the fact that the patients were fairly elderly, and the average BMI of a senior patient is higher than that of a younger patient, 25-30 being a fairly normal value. Malnutrition, as well as high obesity is a prognostic factor of mortality for the elderly, meaning that the BMI value of under 25 or over 30 acts as a high risk factor. As only approximately 58.2% patients had a recorded BMI value, this factor was found to be fairly unreliable since utilization of this parameter in the analysis results in a considerable loss of power.. The BMI is a factor that strongly correlates to the muscle area of the body. This was noted in the analyses of the significance of the BMI factor in a multivariable analysis, and was therefore abandoned from the analysis. When the BMI factor was excluded from the analysis, its effect no longer overwhelmed the psoas muscle area factor, and a result for the psoas muscle area could be noticed.

BMI also exhibits other difficulties. As the BMI grows, it does not correlate linearly to the body’s muscle mass. An obese patient may have a low muscle consistency in ones body, even though the BMI value is high. In addition, a patient with a very high muscle consistency and low fat consistency can be shown as obese in a high BMI value. Consequently, the BMI is not a completely reliable factor in assessing the patient's sarcopenia degree. In addition, the values needed to determine BMI, height and weight of a patient, were not recorded in 58.2% of our patient data from 2010 until 2013, and so the information is missing. This results in selection bias which converts to overall survival bias.

A key strength of this study was that the patient data gathered was relatively large and extensive. However, some patients may have been lost in the process for multiple reasons. For example, data gathered was from a single registry and some patients may have been excluded in the first search of the vascular surgery patients. In addition, possible human errors may have occurred in any part of the study and data assessing, thus being the weakness of the study.

The present study suggests that measuring PMA from MRI may be a considerable prognostic factor for clinical use. This aligns with the previous studies of the subject. More research is needed to determine the significance of psoas muscle area in relation to mortality and overall health of the patients. In addition, the potential association of PMA with mortality in different Fontaine classes remains to be further studied. Additional studies may clarify our understanding of the psoas muscle areas effect on patient health as a prognostic factor. The data received from our research can help determine which patients should be treated surgically and where and to whom the resources should be directed. This can have a future role in the treatment of critical limb ischemia patients. Furthermore this can improve the quality of the given medical treatment and improve the overall safety of the patient.

5 REFERENCES

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