J Cachexia Sarcopenia Muscle
DOI 10.1007/s13539-014-0147-9

LETTER TO THE EDITOR

Relationship between arterial stiffening and skeletal muscle atrophy in hemodialysis patients: a gender comparative study

Akihiko Kato · Takako Takita · Hiromichi Kumagai

Received: 2 April 2014 / Accepted: 5 May 2014

Dear Editor,

Composition of regional muscle and fat masses are related to arteriosclerotic changes in the general population [1]. This study was aimed to clarify the association of muscle mass in the lower limbs and abdominal fat mass with arteriosclerotic parameters in patients on chronic hemodialysis (HD). We measured abdominal subcutaneous fat mass area (ASFA), abdominal visceral fat mass area (AVFA), and thigh muscle area (TMA) from computed tomography (CT) images and adjusted those by body mass index (BMI) in 124 HD patients (age 61±11 [37–79]years, time on HD 11±10 [0–36]years, male/female=84/40). Brachial-ankle pulse wave velocity (baPWV) and ankle brachial pressure index (ABI) were also measured together and automatically in CAVI-VaSera VS-1000 (Fukuda Denshi Co, Ltd, Tokyo, Japan) just before HD session.

A significant association was found between baPWV and TMA/BMI ratio in male ($r=-0.32$, $p<0.01$). Male patients in the top tertile of baPWV had a significantly lower TMA/BMI ratio when compared with those in the middle tertile and those in the bottom tertile (Table 1).

TMA/BMI ratio was also correlated with ABI ($r=0.46$, $p<0.01$) in female patients. There was a significantly lower TMA/BMI ratio in patients with the lowest ABI compared to those with the second and with the highest tertile (Table 2). There was rather an inverse association between AVFA/BMI ratio with baPWV in women ($r=-0.38$, $p<0.05$).

A multiple linear regression analysis adjusted by conventional, nutritional, and anthropometric parameters revealed that TMA/BMI was independently associated with baPWV in male, while with ABI in female (Table 3). In contrast, there was no relationship between AVFA/BMI and ASFA/BMI ratios and arteriosclerotic parameters in men.

It has been demonstrated that skeletal muscle atrophy is associated with accelerated arteriosclerosis. TMA is inversely associated with baPWV in general subjects [2, 3]. A higher PWV is related to a more profound decline in sarcopenic index in older men [4]. Skeletal muscle mass to visceral fat area ratio is also inversely associated with baPWV [5]. In this study, we showed that TMA/BMI ratio was independently associated with baPWV in male, while with ABI in female HD patients, suggesting a possible association of muscle wasting with arteriosclerotic changes in HD patients.

Visceral adiposity is linked to arteriosclerosis. AVFA is positively correlated with baPWV and carotid-femoral PWV in general subjects [2, 6]. Visceral fat level was a predictor of carotid-femoral PWV in peritoneal dialysis patients [7]. A positive relationship between AVFA and baPWV was also observed in diabetic HD patients [8]. In this study, however, AVFA/BMI was rather negatively associated with baPWV in female HD patients. The reasons for this discrepancy are not known, but may be due to a well-preserved nutritional status in female patients with abdominal adiposity. An increased body fat mass volume is paradoxically associated with better outcomes in HD patients [9]. The protective role of accumulated trunk fat on subclinical vascular damage, assessed by carotid-radial PWV, was also observed in the elderly women [10].

In summary, we found that reduced TMA/BMI ratio was independently associated with increased baPWV in male, while with decreased ABI in female patients. The findings

A. Kato (✉)
Blood Purification Unit, Hamamatsu University Hospital, 1-20-1 Handayama, Higashi-ku, Hamamatsu 431-3192, Shizuoka, Japan
e-mail: a.kato@hama-med.ac.jp

T. Takita
Department of Internal Medicine, Maruyama Hospital, Hamamatsu, Shizuoka, Japan

H. Kumagai
Department of Clinical Nutrition, School of Food and Nutritional Sciences, University of Shizuoka, Shizuoka, Japan

Published online: 05 June 2014

Table 1 Baseline characteristics according to the baPWV tertile

Clinical parameters	Male (n=84)			Female (n=40)		
	1st tertile (<12.8)	2nd tertile (12.8≤<14.8)	3rd tertile (14.8≤)	1st tertile (<12.2)	2nd tertile (12.2≤<14.7)	3rd tertile (14.7≤)
Age (years)	54±12	61±9*	67±10**#	55±13	62±9*	70±6**#
HD duration (years)	14±11	9±8	10±10	13±12	11±9	13±12
Diabetes (%)	11	29	36	8	7	23
Creatinine (mg/dL)	13.6±3.4	13.9±2.3	12.3±3.1#	11.1±3.4	11.5±1.7	9.2±1.7#
Albumin (g/dL)	3.8±0.3	3.7±0.2	3.6±0.3	3.6±0.3	3.7±0.3	3.6±0.3
Calcium (mg/dL)	9.0±1.0	9.2±0.8	9.0±0.9	9.3±0.7	9.6±0.8	8.8±1.0
Phosphorous (mg/dL)	5.7±1.3	6.1±1.4	5.6±1.5	5.8±2.1	5.4±1.9	5.2±1.3
hs-CRP (mg/L)	6.5±23.9	8.5±29.8	6.6±19.5	1.5±2.5	4.3±13.2	2.3±5.4
Transthyretin (mg/dL)	33.1±8.6	30.2±6.4	26.5±7.5**	27.7±7.5	29.0±7.8	25.5±7.7
Total cholesterol (mg/dL)	159±41	145±31	142±29	183±32	182±48	154±33*
HDL-C (mg/dL)	53±20	47±13	46±12	51±14	56±16	47±15
Hemoglobin (g/dL)	11.2±1.3	10.5±1.4	11.1±1.1	11.2±1.1	10.5±0.8	10.1±1.2
Total lymphocyte count (/μL)	1320±510	1340±530	1100±510	1440±520	1270±510	1010±220
BMI (kg/m^2)	20.6±2.8	21.9±3.0	21.2±2.9	19.8±2.7	20.1±2.7	18.5±1.9
ASFA/BMI	5.5±2.0	6.2±2.3	6.0±2.3	6.8±2.4	8.7±3.7	5.5±2.4#
AVFA/BMI	3.6±2.6	5.1±3.0	4.2±2.8	4.2±3.1	3.8±2.5	1.8±0.9*#
TMA/BMI	10.1±1.9	9.8±1.7	8.7±2.3*	7.1±2.0	8.7±2.5	7.2±1.9
Systolic blood pressure (mmHg)	120±20	142±21**	161±27**#	107±26	137±20**	148±21**

HD hemodialysis, *hs-CRP* highly sensitive C-reactive protein, *HDL-C* HDL cholesterol, *BMI* body mass index, *ASFA* abdominal subcutaneous fat area, *AVFA* abdominal visceral fat area, *TMA* thigh muscle area

*p<0.05, **p<0.01 vs. the lowest tertile; #p<0.05 vs. the middle tertile

Table 2 Baseline characteristics according to the ABI tertile

Clinical parameters	Male (n=84)			Female (n=40)		
	1st tertile (<1.04)	2nd tertile (1.04≤<1.14)	3rd tertile (1.14≤)	1st tertile (<1.00)	2nd tertile (1.00≤<1.10)	3rd tertile (1.10≤)
Age (years)	64±9	63±10	55±12**	69±11	59±11*	59±10*
HD duration (years)	11±10	10±9	12±10	17±13	10±10	11±9
Diabetes (%)	30	31	14	8	7	21
Creatinine (mg/dL)	12.2±2.4	13.8±2.6*	13.7±3.7	10.0±2.3	10.8±2.4	11.1±3.0
Albumin (g/dL)	3.6±0.3	3.7±0.2	3.8±0.3	3.5±0.3	3.7±0.3	3.8±0.3*
Calcium (mg/dL)	8.9±0.9	9.0±0.8	9.1±1.0	9.4±1.1	9.1±0.9	9.2±0.7
Phosphorous (mg/dL)	5.6±1.3	6.1±1.5	5.7±1.4	5.1±1.1	6.1±2.1	5.2±1.7
hs-CRP (mg/L)	15.2±34.0	1.8±2.5	5.2±18.2	1.0±1.2	6.2±13.8	0.7±0.7
Transthyretin (mg/dL)	26.8±6.9	29.9±7.3	32.3±8.6**	25.4±5.1	26.8±7.6	29.9±9.2
Total cholesterol (mg/dL)	146±26	143±43	158±33	183±41	163±30	174±48
HDL-C (mg/dL)	52±19	45±14	49±12	52±11	52±18	51±16
Hemoglobin (g/dL)	10.8±1.5	10.8±1.2	11.2±1.2	10.5±0.9	10.8±1.1	10.5±1.3
Total lymphocyte count (/μL)	1230±490	1190±480	1340±580	1170±390	1300±500	1240±510
BMI (kg/m^2)	20.7±2.1	21.4±2.7	21.5±3.2	19.1±2.5	19.2±2.7	20.1±2.3
ASFA/BMI	5.7±2.1	5.7±2.3	6.2±2.2	6.9±27	6.3±2.7	7.8±3.7
AVFA/BMI	4.0±2.9	4.5±2.8	4.6±2.9	3.7±2.2	2.7±2.6	3.4±2.8
TMA/BMI	9.4±2.6	9.4±1.8	9.7±1.7	6.3±2.0	8.2±2.0*	8.3±2.3*
Systolic blood pressure (mmHg)	148±35	139±25	136±22	116±32	144±24	130±23

HD hemodialysis, *hs-CRP* highly sensitive C-reactive protein, *HDL-C* HDL cholesterol, *BMI* body mass index, *ASFA* abdominal subcutaneous fat area, *AVFA* abdominal visceral fat area, *TMA* thigh muscle area

*p<0.05, **p<0.01 vs. the lowest tertile

Table 3 Independent determinants of baPWV and ABI in male and female patients

Gender	Parameters	Standardized regression coefficient	*F* value	R^2	*P* value
1. baPWV					
Male	Systolic blood pressure	40.6	63.5	0.44	<0.01
	Age	30.9	26.1	0.24	<0.01
	Transthyretin	44.9	11.4	0.13	<0.01−
	TMA/BMI ratio	13.1	9.4	0.10	<0.01−
	Albumin	4.1	5.0	0.06	0.03
	Total lymphocyte count	1895.1	4.5	0.05	0.04−
	Total cholesterol	191.0	4.5	0.05	0.04−
Female	Systolic blood pressure	56.2	17.0	0.29	<0.01
	Age	39.5	7.9	0.17	<0.01
	Total lymphocyte count	2122.4	7.1	0.16	0.01
	AVFA/BMI ratio	7.8	6.3	0.12	0.02
	Hemoglobin	12.3	4.4	0.10	0.04
2. ABI					
Male	Transthyretin	17.6	8.6	0.05	0.04−
Female	TMA/BMI ratio	0.55	10.2	0.21	<0.01
	Age	88.3	4.9	0.11	0.03
	Time on hemodialysis	35.4	4.1	0.10	<0.05

We examined the determinants of baPWV and ABI with a stepwise multiple-regression analysis using the 15 parameters (age, time on HD, serum calcium, phosphorous, albumin, total cholesterol, HDL cholesterol, TTR, log-transformed hs-CRP, hemoglobin, total lymphocyte count, systolic blood pressure, AVFA/BMI, ASFA/BMI, and TMA/BMI)

BMI body mass index, *AVFA* abdominal visceral fat area, *TMA* thigh muscle area

support a possible relationship between arteriosclerosis and thigh muscle atrophy even in the dialysis population.

Acknowledgment The authors certify that they comply with the ethical guidelines for authorship and publishing of the *Journal of Cachexia, Sarcopenia and Muscle* (*von Haehling S*, *Morley JE*, *Coats AJS*, *Anker SD. Ethical guidelines for authorship and publishing in the Journal of Cachexia, Sarcopenia and Muscle. J Cachexia Sarcopenia Muscle. 2010;1:7-8*). Akihiko Kato, Takako Takita, and Hiromichi Kumagai declare that they have no conflict of interest. This study was approved by the appropriate ethics committee (Maruyama Hospital, Hamamatsu, Japan) and has therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

References

1. Debette S, Leone N, Courbon D, et al. Calf circumference is inversely associated with carotid plaques. Stroke. 2008;39:2958–65.
2. Kohara K, Ochi M, Tabara Y, et al. Arterial stiffness in sarcopenic visceral obesity in the elderly: J-SHIPP study. Int J Cardiol. 2012;158:146–8.
3. Ochi M, Kohara K, Tabara Y, et al. Arterial stiffness is associated with low thigh muscle mass in middle-aged to elderly men. Atherosclerosis. 2010;212:327–32.
4. Abbatecola AM, Chiodini P, Gallo C, et al. Pulse wave velocity is associated with muscle mass decline: Health ABC study. Age. 2012;54:469–78.
5. Kim TN, Park MS, Lim KI, et al. Skeletal muscle mass to visceral fat area ratio is associated with metabolic syndrome and arterial stiffness: the Korean Sarcopenic Obesity Study (KSOS). Diabetes Res Clin Pract. 2011;93:285–91.
6. Lee Y, Shin H, Vassy JL, et al. Comparison of regional body composition and its relation with cardiometabolic risk between BMI-matched young and old subjects. Atherosclerosis. 2012;225:258–65.
7. Lu Q, Cheng LT, Wang T, et al. Visceral fat, arterial stiffness, and endothelial function in peritoneal dialysis patients. J Ren Nutr. 2008;18:495–502.
8. Yurigi T, Morimoto S, Okamoto T, et al. Accumulation of visceral fat in maintenance hemodialysis patients. Clin Exp Nephrol. 2012;16:153–63.
9. Kakiya R, Shoji T, Tsujimoto Y, et al. Body fat mass and lean mass as predictors of survival in hemodialysis patients. Kidney Int. 2006;70:549–56.
10. Fantin F, Rossi AP, Cazzadori M, et al. Central and peripheral fat and subclinical vascular damage in older women. Age Ageing. 2013;42:359–65.