Pelvic Artery Calcification Sore (PACS) is a marker of vascular calcification in male hemodialysis patient

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Abstract

Background and objectives

Patients who undergo hemodialysis often suffer from cardiovascular disease (CVD), and evaluation of coronary artery calcification is extremely important. These evaluations are typically conducted using a noninvasive method including electron beam computed tomography (CT) or multi-detector CT, and the Agatston method to calculate the coronary artery calcification score (CACS). However, it is difficult to use for patients undergoing dialysis. Because patients undergoing dialysis is too strong in coronary artery calcification, and results become incorrect. Therefore we were looking for a calcified evaluation place peculiar to a patients undergoing dialysis.

Design, setting, participants, and measurements

We obtained pelvic artery calcification scores (PACS) using a 64-row multi-slice CT to assess the presence of calcification within a triangular space bordered by bordered by osseous structure. We used the Agatston method to calculate PACS. We compared male patients undergoing dialysis with male patients with normal renal function.

Result

Patients undergoing hemodialysis had a significantly higher incidence of pelvic artery calcification than normal controls (79.7% vs 5.5%). In the dialysis group, CACS was 1660.2 (0–9056.1), and PACS was 48.8 (0–2943.1). We found a correlation between PACS and CACS and between PACS and dialysis period.

Conclusions

We found penile artery calcification in male patients undergoing hemodialysis more than normal controls, and it was possible to quantify PACS using the Agatston method. This study suggested the possibility that PACS became the vascular calcification evaluation method of the hemodialysis patient.

Introduction

Patients undergoing hemodialysis often suffer from because of cardiovascular disease (CVD)[1)], and have a higher prevalence of coronary artery disease than the general population[2)]. Arterial calcification relates to overall prognosis in patients undergoing hemodialysis[3)]. Most evaluations for coronary artery calcification are noninvasive and use electron beam computed tomography or multi-detector CT (MDCT), and the Agatston method[4)] to generate a coronary artery calcification score (CACS). However, this method requires electrocardiogram gating and a CT device capable of respiratory gating. This method is not generally easily performed at many medical facilities. Moreover, this evaluation method becomes less useful if the numerical value of CACS is too high, as is the case with patients who demonstrate very severe coronary artery calcification[5)].

Previous studies indicate that erectile dysfunction (ED) is a vascular disorder that is associated with CVD[6)]. Many males with CVD also exhibit ED[7,8)]. A recent rat CKD model study revealed that the internal pudendal artery was susceptible to reduced vascular function with calcification[9)].

In this study, we sought to evaluate mineralization in patients undergoing

hemodialysis. We measured the vascular disorder related to ED (pelvic arterial calcification) in patients undergoing hemodialysis.

Material & Methods

The Seitetsu Memorial Hospital ethics committee approved this study (approval number: 001). All patients provided written informed consent for participation prior to any study procedures.

Subjects

Male patients undergoing hemodialysis were included in this study. We excluded patients who could not undergo pelvic imaging because of hip arthroplasty or other contraindicated conditions. Control subjects were males with normal renal function (e-GFR ≥ 60 ml/min/1.73 ml/min/m^2).

Arterial calcification

CACS and pelvic artery calcification score (PACS) were assessed on images obtained by a 64-row multi-slice CT (Aquilion/CXL edition: Toshiba Medical Systems, Tokyo, Japan) to examine if calcification existed within a predefined triangular region of interest (ROI). The upper border of this region was the inferior pubic ramus, the anterior border was the posterior pubis, and lower end

was inferior ischial ramus (Fig. 1). PACS was determined using a conventional (non-helical) scan with a slice thickness of 2 mm to evaluate the presence of calcification existing within ROI (Fig. 2).

For CACS, we used a 3D medical image processing workstation (Ziostation 2: Ziosoft, Inc., Tokyo, Japan) according to the method described by Agatston[4]. Using the electrocardiogram gating imaging method, we obtained conventional (non-helical) scans from the ventricular base toward the ventricular apex. Scans were conducted using one breath held to achieve continuous imaging of 20 slices, with a slice thickness of 3 mm.

ED

We use IIEF (International Index of Erectile Function) -5 score for the ED evaluation of the patient on dialysis.

Laboratory examination

We measured serum albumin, serum creatinine (Cr), urea (UN), calcium (Ca), serum phosphate (P), and intact para-thyroid hormone (i-PTH) levels in all patients. For patients undergoing hemodialysis, blood samples were taken pre-dialysis. We calculated adjusted Ca levels using Payne's formula[10]:

Adjust Ca (mg/dL) = calcium (mg/dL) − albumin (g/dL) + 4.0

Statistical Analysis

For CACS, PACS, and other dependent variables, we calculated medians (maximum value − minimum value). We used a chi-square test to determine the presence of pelvic arterial calcification and Spearman's rank correlation coefficients to determine relationships between variables. For statistical analysis, we used JMP11 (SAS Institute, Cary, NC, USA), and a significant differences were determined when $p < 0.05$.

Results

Subjects

Of the 66 male patients undergoing hemodialysis, 59 were included in the study (dialysis) group. The control group consisted of 52 men with a normal renal function (e-GFR ≥ 60 ml/min/1.73 ml/min/m^2). The dialysis and control groups were comparable in age, with the average ages of the two groups being 65 years.. Patients in the dialysis group had higher UN and Cr levels than in the control group subjects (Table 1).

CACS and PACS

In the dialysis group, the incidence of coronary artery calcification was 97.9%

(47/48 patients) and that of pelvic artery calcification was 79.7% (47/59 patients). This was significantly higher than the 5.5% incidence observed in the control group (3/55 patients; $p < .0001$). In the dialysis group, CACS was 1660.2 (0–9056.1) and PACS was 48.8 (0–2943.1; Table 1).

ED

The mean of the score is 9.18(5-21). All patients are ED. We were not able to evaluate the relations with the PACS.

Discussion

In the dialysis group, the incidence of coronary artery calcification was similar to that observed in previous studies[11]. We were able to quantify PACS and CACS by using the method described by Agatston et al.[4] The study ROI included the internal pudendal, penile, dorsal penile, and deep penile arteries. We mainly found calcification in the penile and dorsal penile arteries (Fig. 2); therefore, it was possible to quantify the calcification in these structures.

Our results revealed a correlation between PACS and CACS (Fig. 3). ED is frequently associated with CVD[6-8, 12-16]. The penile artery of is 1-2 mm in diameter, and it was much smaller than the coronary artery diameter, which was

3-4 mm. Consequently, in penile arteries, ischemic symptoms represented earlier disease progression[17]. Because of this, we expected that the incidence of pelvic arterial calcification was higher than that of coronary artery calcification; however, our study revealed the opposite result. The incidence of pelvic arterial calcification was lower than that of coronary artery calcification. The reason for this difference was most likely related to the disease status. In normal adults, atherosclerosis causes calcification, whereas in patients undergoing dialysis, coronary artery calcification was a sign of mineral metabolism disorder[18]. This calcification occurred in the vascular smooth muscle layer.

We examined the relationship between PACS and mineral metabolism disorders, peculiar to patients undergoing dialysis, such as corrected Ca, serum P, intact-PTH levels, but no correlation was noted between PACS and these other factors. It was possible that corrected Ca and serum P levels were approximately the same as those of the control group; all such control subjects had normally functioning kidneys (Table 1). Additionally, intact-PTH levels of 89.8% of patients (53/59) were well controlled and within the normal control range, “intact-PTH ≥ 60 pg/ml or more but 240 pg/ml or less,” as noted in the Clinical Practice Guidelines for CKD-MBD, published by the Japanese Society

for Dialysis Therapy[19]. We believed that these reasons why no correlations, found between PACS and mineral metabolism disorders was unique to the patients undergoing dialysis.

Phosphorus absorbents, without Ca content, affected of coronary artery calcification[20]. A correlation between PACS and dialysis period was noted (Fig. 4), and the future studies should investigate how specific factors related to hemodialysis, such as Ca and P metabolism disorders, drug, dialysate, and dialyzer influenced PACS development.

This study has several limitations. First, this is a single hospital study and the number of patients in each arm too small. Second, this examination is retrospective study. The most significant limitation of this study was in our all-male patient cohort. Breast arterial calcification affected of calcification of the tunica media and peripheral arteries in female patients undergoing dialysis[21,]. Future studies may find it is necessary to use sex-based evaluation methods for determining the status of the blood vessel calcification in patients undergoing dialysis.

Conclusion

Penile artery calcification was found in many male patients undergoing dialysis, and it was possible to obtain PACS using the Agatston method. This study suggested the possibility that PACS became the vascular calcification evaluation method of the male hemodialysis patient.

Disclosures

None

Acknowledgments

The authors declare that there are no conflicts of interest.

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Figures and legends

Fig. 1: The evaluation area of pelvic artery calcification

Pelvic artery calcification was evaluated within a triangular space whose upper border was the lowest extremity of the pubis, the anterior border was the posterior pubis, and the lower end was the inferior ischial ramus.

Fig. 2: Pelvic artery calcification score (PACS)

PACS was obtained by a conventional (non-helical) scan with a slice thickness of 2 mm to determine the presence of calcification within the evaluation ROI and the calculation score was assessed using the method by Agatston.

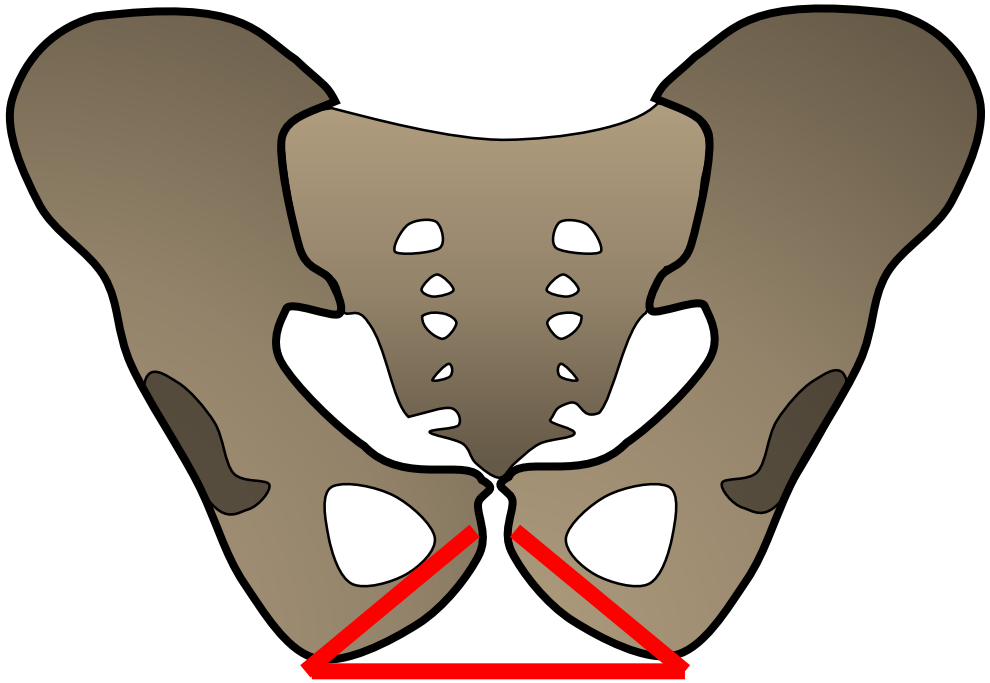
Fig. 3: Correlation between PACS and CACS

Fig. 4: Correlation between PACS and dialysis vintage and between CACS and dialysis period

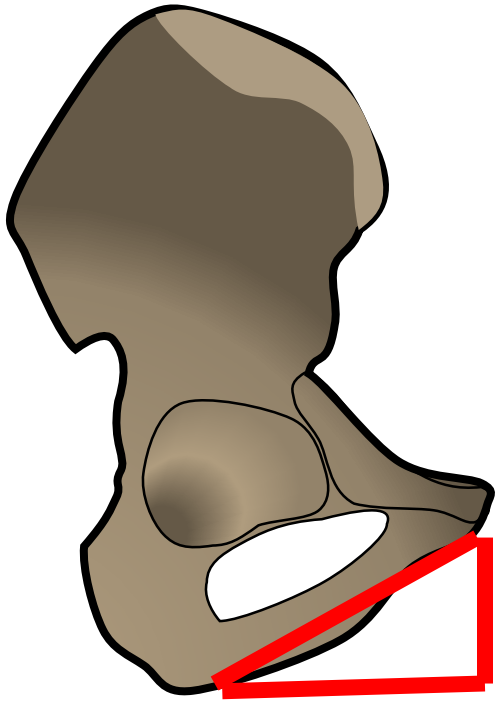
	Dialysis group	Control group	P value
Age（years）	65(31-95)	65(51-74)	0.92
UN（mg/dL）	57(27-81.1)	15.8(9.2-14.8)	<.0001
Cr（mg/dL）	10.7(4.5-16.6)	0.7(0.46-0.99)	<.0001
Adjusted Ca（mg/dL）	8.8(7.5-15.5)	9.4(8.3-10.1)	0.73
P（mg/dL）	5.5(3.3-8.6)	3(2-4.2)	0.36
Intact-PTH（pg/mL）	146.8（23.3-814.4）	—	—
Diabetes (%)	45.7	8	<.0001
Hypertension (%)	62	24	0.05
The incidence of pelvic artery calcification（%）	79.7 (47/59) ＊	5.5 (3/55) ＊	<.0001
The incidence of coronary artery calcification（%）	97.9 (47/48) ＊	—	—
CACS	1660.2（0-9056.1）		
PACS	48.8（0-2943.1）		

Median（MIN－MAX）

＊（positive cases／total cases）

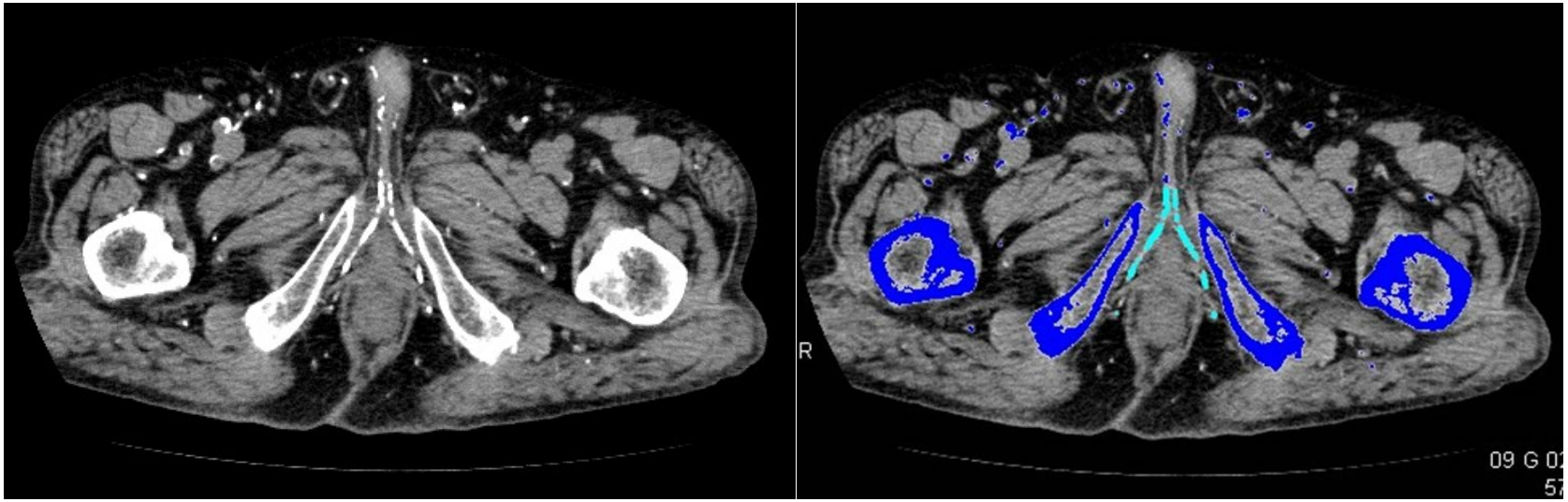


frontal view

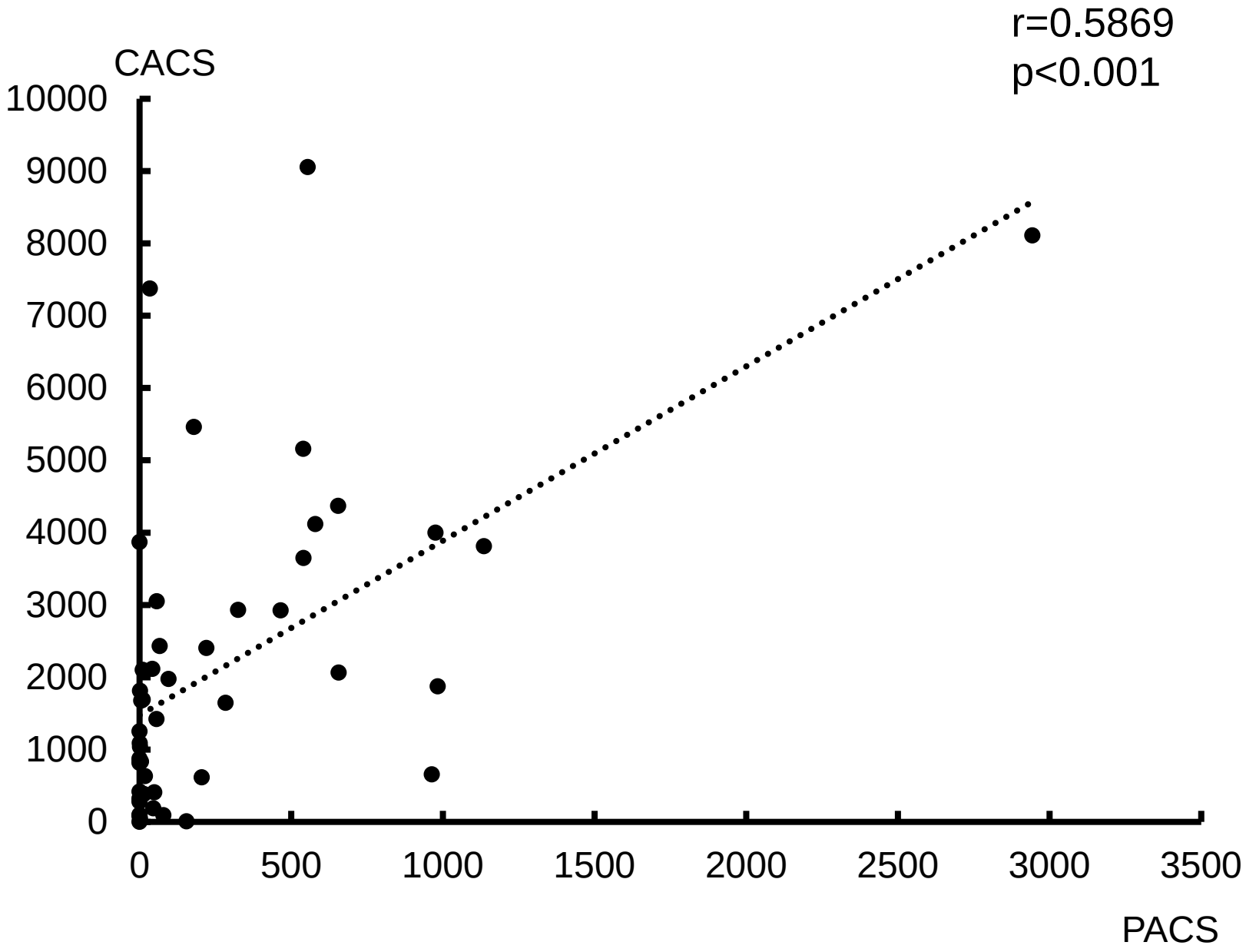


right lateral view

Upper : Inferior pubic ramus
Anterior : The posterior of pubis
Lower : Inferior ischial ramus



Label/Block	Voxel	Volume	MIN	MAX	AVE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p<0.001
CACS
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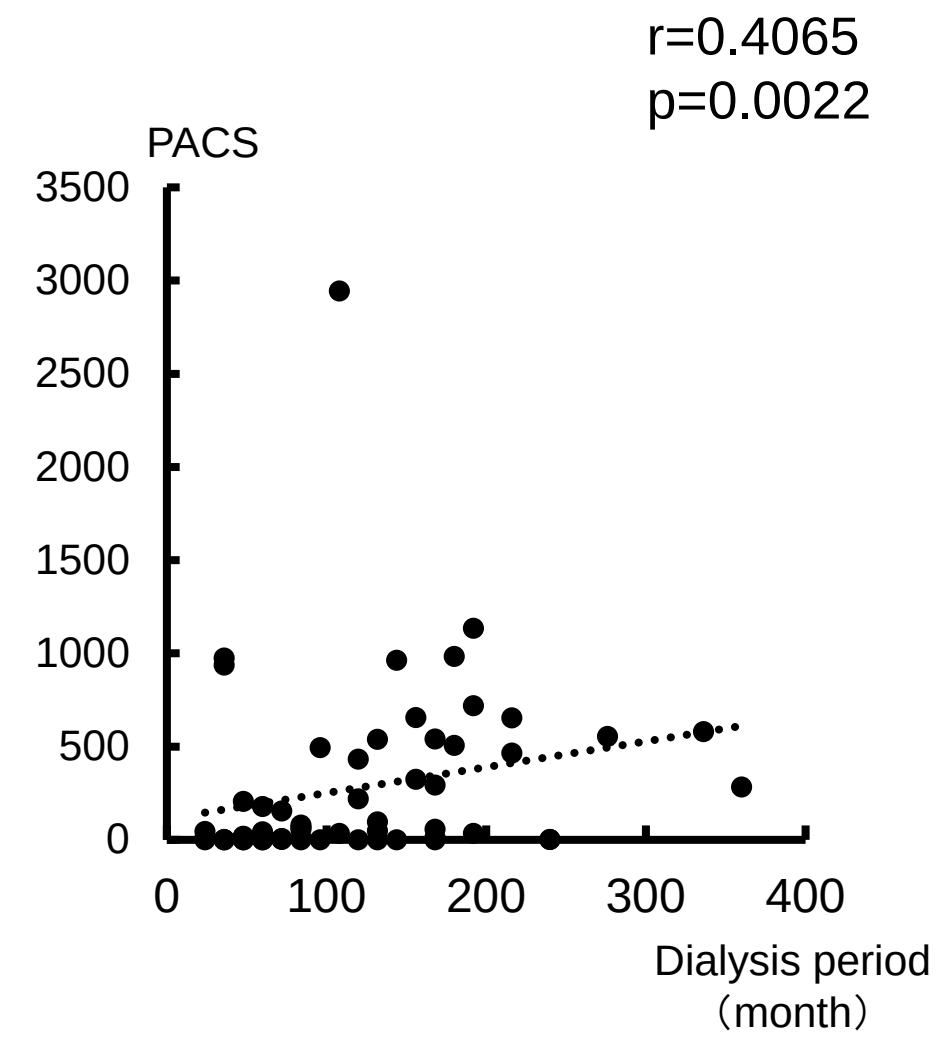
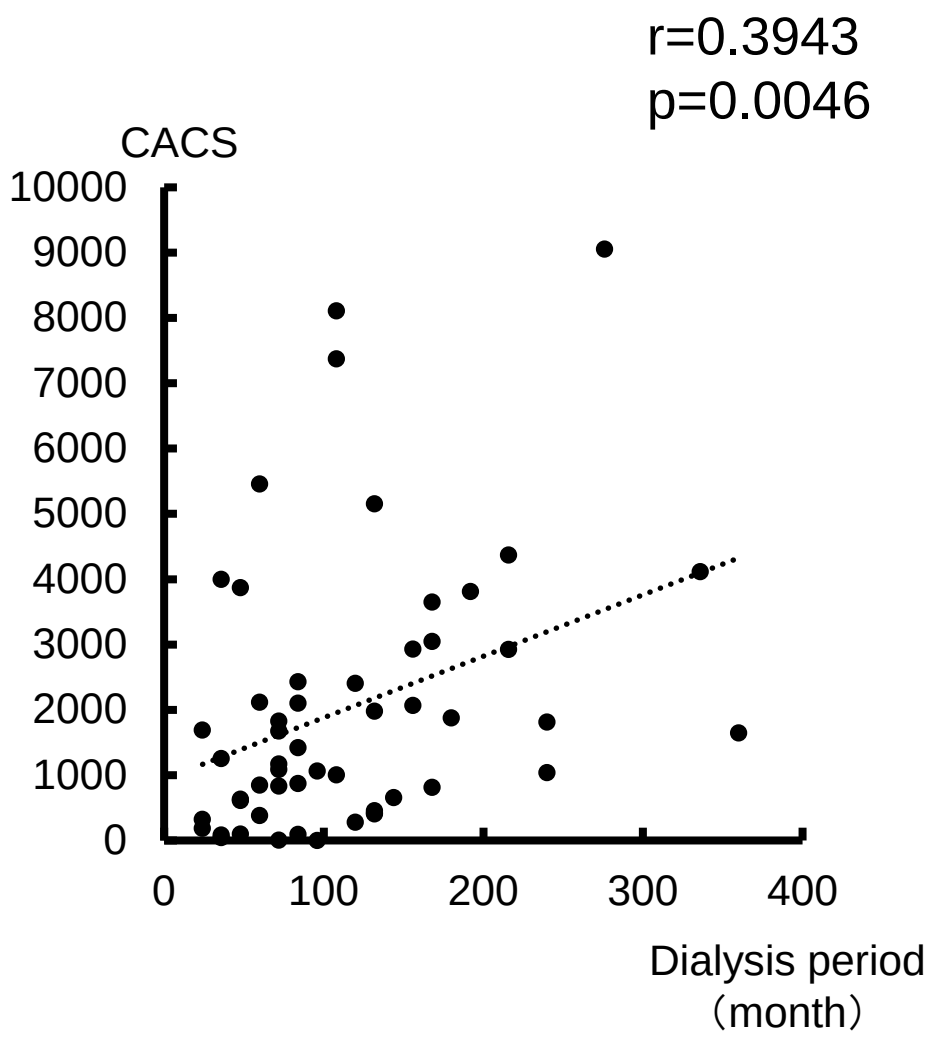
8000
7000
6000
5000
4000
3000
2000
1000
0
0
500
1000
1500
2000
2500
3000
3500
PACS


r=0.4065
p=0.0022
PACS
3500
3000
2500
2000
1500
1000
500
0
0
100
200
300
400
Dialysis period
（month）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CACS
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
0
100
200
300
400
Dialysis period
（month）