Impact of the Ratio of Visceral to Subcutaneous Adipose Tissue in Donor Nephrectomy Patients

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ABSTRACT

Objective. It was reported that a metabolic syndrome affected the remaining renal function after living donor nephrectomy. However, the measurement of waist circumference is unclear because it cannot distinguish between visceral adipose tissue (VAT) and subcutaneous adipose tissue (SAT). We investigate the clinical correlation between body adipose tissue and renal function recovery after living donor nephrectomy.

Methods. From July 2013 to February 2015, 75 living kidney donors were enrolled. The VAT and SAT were measured by preoperative computed tomography (CT) scan. Body mass index (BMI), VAT, SAT, and VAT-to-SAT ratio were analyzed according to a postoperative renal function recovery. Receiver operating characteristic (ROC) was performed to predict estimated glomerular filtration rate (eGFR) less than 60 mL/min/1.73 m^2 at postoperative 6 months for BMI, VAT, SAT, and VAT-to-SAT ratio.

Results. The lowest value of eGFR (57.52 ± 11.20 mL/min/1.73 m^2) was measured at postoperative day 7. There was no statistically significant difference in eGFR between 1 month and 3 months. BMI, VAT, SAT, and VAT-to-SAT ratio showed a statistically significant correlation with each other (Pearson correlation, $P < .05$). Also, the recovery time of eGFR was correlated with VAT-to-SAT ratio; it was significant at postoperative 1, 3, and 6 months. VAT-to-SAT ratio (0.654, 95% confidence interval 0.525–0.783, $P = .024$) had higher predictive value in ROC.

Conclusion. We developed a new variable to predict the value of lower eGFR (less than 60 mL/min/1.73 m^2) at a postoperative 6 months in living kidney donor. According to a CT scan, VAT-to-SAT ratio can predict renal function recovery.

KIDNEY transplantation can reduce the burden of dialysis in the recipient. However, there is a possibility of inducing chronic kidney disease in the living kidney donor [1]. Therefore, selection of the preoperative donor is crucial. Recent studies have reported on the appropriate criteria for screening donors, but despite the currently available evidence, donor safety cannot be fully guaranteed [2]. For this reason, the current donor selection criteria should be modified based on the knowledge currently available for proper living kidney donor selection [2–5].

The presence of metabolic syndrome has been studied as a significant factor in the kidney donor selection process [6]. Components of the disease include blood pressure and body mass index (BMI), both of which have been shown to affect kidney function in the living kidney donor [7]. However, the widely used BMI criteria for overweight and obesity is not suitable for determining visceral obesity [8,9]. Visceral obesity quantitatively measured preoperatively as a ratio of visceral adipose tissue (VAT) to subcutaneous adipose tissue (SAT) has not been well investigated as a means to predict outcomes in living kidney donation. Moreover, the

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measurement of waist circumference is unclear because it cannot distinguish between VAT and SAT.

In this study, we investigate the clinical correlation between body adipose tissue and renal function recovery after living donor nephrectomy.

METHODS

The study protocol was reviewed and approved by the Institutional Review Board of our institution, and all subjects gave written informed consent. Between July 2013 and February 2015, 75 living kidney donors were enrolled in this study. All donor nephrectomies were performed by 2 surgeons by video-assisted mini-incision surgery technique, which has been previously described [10].

We evaluated routine blood tests, diethylenetriaminepentaacetic acid renal scans, and computed tomography (CT) angiography for all living kidney donors. After surgery, regular lab tests were performed daily for 3 days until the patients were discharged. We followed the patients for 6 months [11]. At 6 months, we identified the donors who showed estimated glomerular filtration rates (eGFR) lower than 60 mL/min/1.73 m^2 as the chronic kidney disease (CKD) group [11]. eGFRs were calculated using the Modification of Diet in Renal Disease formula. BMI was calculated by dividing the body weight in kilograms by the height in meters squared.

CT scans have been reported as the gold standard method for estimating visceral adiposity. VAT and SAT were measured at the level of the umbilicus using CT. After the border of the intra-abdominal cavity was outlined on the CT scan, the cross-sectional surface areas of the visceral fat and subcutaneous fat were calculated by a single urologist using Xelis CT software (INFINITT, Seoul, Korea). This software electronically determines the adipose tissue area by setting the attenuation values for a region of interest within a range of −250 to −50 Hounsfield (Fig 1) [12].

Continuous data are presented as the mean ± standard deviation and categorical data as numbers (%).The relationships between BMI, VAT, SAT, VAT-to-SAT ratio and postoperative renal function recovery were analyzed. Furthermore, the associations between perioperative measured values and recovery of renal function were analyzed by regression analysis, and receiver operating characteristics (ROC) curves were generated. A P value $< .05$ was regarded as statistically significant. All data analyses were processed using SPSS software version 23.0 (IBM SPSS Statistics, IBM Corporation, Armonk, NY, USA).

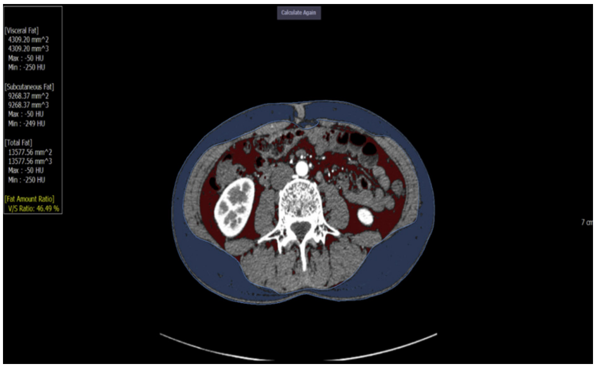

Fig 1. Axial computed tomography images of the level of the umbilicus used for assessment of abdomen adiposity. The red region represents the visceral adipose tissue, and the blue region represents the subcutaneous adipose tissue.

RESULTS

The study population consisted of 75 living donors with a mean age was 42.4 years, and follow-up was 6 months. Baseline demographic and characteristics of donors are summarized in Table 1. The mean BMI was 23.5 ± 2.6 kg/m^2. There were 33 (44.0%) male donors and 42 (56.0%) female donors. Among the 75 surgeries, 13 (17.3%) were performed on the right side and 62 (82.7%) on the left. The mean preoperative creatinine level was 0.74 ± 0.17 mg/dL, and eGFR was 103.0 ± 19.7 mL/min/1.73 m^2. Mean preoperative BMI was 23.6 ± 2.7, mean VAT was 73.0 ± 41.6 cm^3, and mean SAT was 117.5 ± 70.2 cm^3 (Table 1). The lowest value of eGFR (57.52 ± 11.20 mL/min/1.73 m^2) was measured on postoperative day 7.

There was no statistically significant difference in eGFR between 1 month and 3 months (Fig 2). BMI, VAT, SAT, and VAT-to-SAT ratio showed a statistically significant correlation with each other (Pearson correlation, $P < .05$). Also, the recovery time of eGFR was correlated with VAT-to-SAT ratio; it was significant at 1, 3, and 6 postoperative months (Table 2). ROC was performed to predict eGFR less than 60 mL/min/1.73 m^2 at 6 postoperative months for BMI, VAT, SAT, and VAT-to-SAT ratio. VAT-to-SAT ratio (0.654, 95% confidence interval 0.525 to 0.783, $P = .024$) had a higher predictive value in ROC (Fig 3).

DISCUSSION

Our study shows that VAT-to-SAT ratio is significantly associated with delayed recovery of renal function. Previous studies reported that metabolic syndrome and its individual

Table 1. General Study Population Characteristics

No. of Donors	75
Sex (%)	
Male	33 (44)
Female	42 (56)
No. laterality (%)	
Left	62 (82.7)
Right	13 (17.3)
Age (y), mean ± SD	42.4 ± 11.3
BMI (kg/m^2), mean ± SD	23.6 ± 2.7
Preoperative eGFR (mL/min/1.73 m^2), mean ± SD	103.0 ± 19.7
Postoperative eGFR (mL/min/1.73 m^2), mean ± SD	
1 d	64.1 ± 13.1
2 d	64.4 ± 14.1
3 d	69.9 ± 16.4
4–5 d	68.4 ± 15.0
1 wk	57.4 ± 11.2
1 mo	63.9 ± 11.3
3 mo	63.4 ± 12.4
6 mo	63.5 ± 12.5
Visceral adipose tissue (cm^3), mean ± SD	73.0 ± 41.6
Subcutaneous adipose tissue (cm^3), mean ± SD	117.5 ± 70.2
VAT-to-SAT ratio, mean ± SD	0.7 ± 0.5

Abbreviations: BMI, body mass index; eGFR, estimated glomerular filtration rate; SAT, subcutaneous adipose tissue; SD, standard deviation; VAT, visceral adipose tissue.