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● *Original Contribution*

PREPERITONEAL FAT TISSUE MAY BE ASSOCIATED WITH ARTERIAL STIFFNESS IN OBESE ADOLESCENTS

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Abstract—Vascular aging is a chronic process, and many negative effects of obesity in this process have been well defined. We assessed arterial stiffness in obese adolescents and evaluated the relationship between intra-abdominal fat distribution and arterial stiffness. Arterial stiffness parameters and pulse wave velocity (PWV) were evaluated in 61 obese adolescents and 58 healthy controls. Carotid-femoral PWV was calculated by arterial tonometry. Additionally, all obese children were evaluated for metabolic syndrome and insulin resistance. Intra-abdominal fat distribution, including subcutaneous, preperitoneal and visceral fat thicknesses, was assessed by ultrasonography. PWVs of obese children were significantly higher than those of healthy controls (5.0 ± 0.7 m/s vs. 4.7 ± 0.5 m/s). Parameters affecting PWV were evaluated by regression analysis. The independent variable in the regression analysis model was PWV, and the dependent variables were age, metabolic syndrome, body mass index and Homeostasis Model Assessment—Insulin Resistance, as well as subcutaneous, preperitoneal and visceral fat tissue thicknesses measured by ultrasonography. The only parameter associated with PWV was preperitoneal fat tissue thickness. Vascular changes related to obesity may begin in adolescence, as illustrated by the increased PWV. Preperitoneal fat tissue may be related to arterial stiffness. Intra-abdominal fat distributions obtained by ultrasonography may provide clinicians with valuable information needed to determine cardiovascular disease risk factors in obese adolescents. (E-mail: hacihamdi@yahoo.com.tr) © **2014 World Federation for Ultrasound in Medicine & Biology.**

Key Words: **Obesity, Adolescent, Intra-abdominal fat distribution, Ultrasound, Preperitoneal fat tissue, Pulse wave volume, Arterial stiffness.**

INTRODUCTION

Obesity in the pediatric population is an important health problem that is increasing in frequency worldwide. This increase in frequency is resulting in more obesity-related problems at earlier ages than expected (Kelly et al. 2008; Orsi et al. 2011). Obesity itself can increase the risk for cardiovascular disease (CVD), and this risk increases further if obesity is accompanied by metabolic syndrome. The risk for CVD increases with earlier age at onset and longer duration of obesity (Lloyd et al. 2010; Logue and Sattar 2011; Nathan and Moran 2008). Obesity may cause disorders of the structure and function of the heart and vessels, which may manifest at a very early age (Juonala et al. 2011).

Vascular aging, namely, arterial stiffness, is expected with advanced age (Boutouyrie et al. 2008; Lacolley et al. 2009; Lee and Oh 2010; Milan et al. 2011). Reneman et al. (1986) were the first to report that arterial distensibility and arterial compliance decrease linearly with age from the third age decade on. However, arterial stiffness can be observed much earlier in obese patients. Obesity can lead to early aging of vessels (Anderson 2006). Increased arterial stiffness is significantly and independently associated with a higher risk for cardiovascular morbidity and mortality (Safar et al. 2006). It has been proposed that the arterial stiffness observed in obese children is related to the risk for CVD observed later in life (Koivistoinen et al. 2010; Raitakari et al. 2005).

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The relationship between visceral fat tissue and atherosclerosis is well known (Ohman et al. 2009). Intra-abdominal fat distribution can be determined, and the thickness of visceral fat tissue can be measured by ultrasonography (Vlachos et al. 2007). Although preperitoneal fat tissue is not visceral fat, it has been associated with a risk for CVD in some studies (Tadokoro et al. 2000). The relationship between intra-abdominal fat distribution and cardiovascular risk factors in children has been evaluated in a few studies (Polat et al. 2008; Tadokoro et al. 2010).

Specific methods are employed to define cardiovascular effects in obese children at an early stage. Peripheral arterial tonometry is a non-invasive method that has been increasingly used to determine pulse wave velocity (PWV) to estimate arterial stiffness (Urbina et al. 2009).

In the study described here, we assessed arterial stiffness in obese adolescents and evaluated the relationship between intra-abdominal fat distribution and arterial stiffness.

METHODS

Patients diagnosed as obese who applied to the adolescent outpatient clinic of the Department of Paediatric Endocrinology were included in this study. Approval was obtained from the local ethics committee. Inclusion criteria were as follows: age >10 y but <18 y; in puberty; body mass index (BMI) in the $\geq$95th percentile based on age and gender; no previous treatment for obesity; no syndrome or endocrinological disease resulting in obesity; no drug use; and no family history of dyslipidemia. BMIs in the control group were in the 15th–85th percentiles. Control patients were not taking any medications, had normal blood pressure and had no history of smoking. Tanner scoring was used for pubertal staging in the patient and control groups, and participants at stages $\geq$II were accepted as pubertal (Marshall and Tanner 1969, 1970). All participants were Turkish and were recruited from an urban area in Turkey.

Weights and heights of the patients and controls were measured by standard methods, and BMIs were calculated using the weight (kg)/height^2 (m) formula. BMI values were evaluated using percentile cards prepared for Turkey according to gender and age, and values above the 95th percentile were accepted as indicating obesity (Bundak et al. 2006). Waist circumference was measured during exhalation, midway between the lowest point of the ribs and the uppermost point of the iliac crest, using a standard, non-elastic measuring tape (Li et al. 2006). All anthropometric measurements were obtained using the same method and performed by the same person.

Blood pressure was measured using the appropriate cuff size and a mercury sphygmomanometer. Systolic and diastolic blood pressures were each measured three times, and the means calculated. Patients were diagnosed with hypertension with respect to age, gender and height norms (National High Blood Pressure Education Program Working Group 2004).

Blood samples were taken from the patient group to determine glucose level, lipid profile and insulin level after fasting at least 12 h. The samples were evaluated immediately in the biochemistry laboratory. Fasting blood glucose levels and lipid profiles were determined with the Beckman Coulter Synchron System (Beckman, Istanbul, Turkey). Insulin levels were measured with the immunoradiometric method (DIAsource INS-IRMA Kit, DIAsource ImmunoAssays, Nivelles, Belgium). The Homeostasis Model Assessment—Insulin Resistance (HOMA-IR) index was calculated (Tetlow and Clayton 2005). Metabolic syndrome was diagnosed using International Diabetes Federation criteria (Zimmet et al. 2007).

Ultrasonographic examinations were performed by an experienced physician (14 y of experience in pediatric radiology and ultrasonography) to define the intra-abdominal fat distribution. All measurements and evaluations were performed by the same person using a SSA 770 Aplio scanner device (Toshiba Medical Systems, Tokyo, Japan). A linear 7.5-MHz probe was used for the superficial examination (subcutaneous and preperitoneal fat tissue measurements), and a 3.5-MHz penetrating convex array probe was used for intra-abdominal visceral fat tissue measurements. The probes were placed perpendicular to the skin surface and scanned parallel to the midline of the abdomen. Two thickness measurements were taken in the longitudinal plane: (i) the thinnest subcutaneous fat tissue just below the xyphoid process in the xypho-umbilical plane and between the skin and linea alba, and (ii) the thickest preperitoneal fat tissue between the linea alba and liver (Fig. 1). Intra-abdominal visceral fat tissue was measured in the axial plane between the inner surface of the abdominal muscles and the frontal surface of the aorta, 0.05 m above the umbilicus (Fig. 2) (Polat et al. 2008). Three measurements each were made, and means were calculated.

Pulse wave velocity was measured by applanation tonometry using a SphygmoCor Version 7.0 Vx (AtCor Medical, Sydney, Australia) device. The probe was connected to a hand-held electrocardiograph (ECG) unit while pressure and electrocardiographic signals were transmitted to a computer (Exper, Datateknik, Istanbul, Turkey). Aortic PWV was measured in sequential recordings of carotid and femoral artery arterial pressure waves and defined as the distance between sampling sites