Visceral fat is considered a key factor in the development of metabolic syndrome and other pathological conditions and diseases associated with obesity. Therefore, analysis of the dynamics of reducing the amount of abdominal visceral fat is important for evaluating the therapeutic effects of different modalities of obesity treatment, including bariatric surgery. In 53 obese patients visceral and subcutaneous abdominal adipose tissue was measured by ultrasonography (US) before and after bariatric surgery, in the period of 1, 3, 6 months. At the same time, standard anthropometric parameters were assessed: body mass (m), BMI, waist circumference (WC), and hip circumference (HC). Five diameters of the visceral abdominal fat (VAF) were measured: IAFT (Intraabdominal Fat Thickness), LV (Lienal Vein), VF (Visceral Fat), MES sum (Mesenterial leafs) and Max PFT (Maximal Preperitoneal Fat Thickness), and three diameters of the subcutaneous abdominal adipose tissue (SCAF): Min SFT (Minimal Subcutaneous Fat), and MaxSFTa and MaxSFTb (Maximal Subcutaneous Fat Thickness a and b). Statistically significant decrease in all anthropometric parameters, except HC was registered 1, 3 and 6 months after the surgery. We registered the decline of almost all US diameters of abdominal adipose tissue in the follow-up period, but statistically significant decrease were found only in the diameters of visceral adipose tissue: IAFT after 1 and 3 months (p=0.031 and p=0.027); VF after 1 month (p=0.031), LV after 6 months (p=0.011), and MES sum after 3 and 6 months (p=0.003 and p=0.028), as well as MaxSFTb, at 1 month follow-up (p=0.015). In the short-term follow-up period after the bariatric surgery, there was a significant decrease in body mass, BMI and WC, and ultrasonography revealed a significant reduction in the diameters of the visceral abdominal fat.

Key words: obesity, ultrasonography, fat tissue, bariatric surgery.

INTRODUCTION

Obesity is an abnormal or excessive fat accumulation in the body, which threatens the health and is, as recent studies show, irreversible condition, without medical treatment. The most commonly used parameter for quantifying obesity is the body-mass index (BMI). People whose BMI is 30 kg/m2 or more, qualify as obese. BMI over 40 kg/m2 indicates severe or morbid obesity. Obesity is considered a predisposition to the development of many cardiovascular and cerebrovascular risk factors diseases such as hypertension, dyslipidemia, diabetes, metabolic syndrome, as well as the development of musculoskeletal disorders or some types of cancer. One of the available methods for the quantification of obesity is to assess the amount of abdominal fat, which could be done in two basic ways: anthropometric measurements (mass, BMI, waist circumference, hip circumference and the ratio of these two values, the upper arm circumference), and radiological imaging methods (computed tomography, ultrasonography, magnetic resonance imaging).

Abdominal adipose tissue is divided into two compartments: subcutaneous and visceral. Visceral adipose tissue is located inside the abdominal cavity. It surrounds organs of the abdominal cavity, and the smaller part is located in the visceral abdominal organs. Extensive Framingham’s study of cardiovascular risk factors showed that increased accumulation of the visceral fat in the abdomen is related to complications of obesity such as type 2 diabetes and coronary artery disease. It was also shown that the correlation between the quantity of visceral fat and atherosclerosis is not dependent on age, overall obesity or subcutaneous adipose tissue volumes. Recent studies suggest different physiological behavior of visceral and subcutaneous adipose tissue. The amount and ratio of two compartments differ depending on gender and ethnicity. It has been reported that there is bigger amount of visceral fat in males, African-American women, Japanese and Indians.
There are two therapeutic approaches in the treatment of obesity: conservative and surgical. Conservative treatment includes the use of low-calorie diet and drugs. Surgical treatment is indicated if the BMI is higher than 40 kg/m², or if the BMI is higher than 35 kg/m², with associated diseases (diabetes, hypertension, hyperlipidemia, etc.).

There are few techniques of bariatric surgery, but mostly used are: laparoscopic Roux-and-Y gastric bypass gastroplasty, vertical * band * gastroplasty, laparoscopic * banding * and stomach * sleeve * gastrectomy. It is expected that the body weight decrease after the bariatric surgery, which correlates with a decrease of the total body fat amount. Ultrasonography is an effective method of quantification of subcutaneous and visceral fat, even when compared with the methods of the "gold standard" in this type of radiological diagnosis: computed tomography and magnetic resonance imaging.

The purpose of this study was to monitor the dynamics of the decrease of amount of abdominal fat in obese patients after the bariatric surgery by measuring certain diameters with ultrasonography, which could indicate the quantity and distribution of two different compartments of abdominal fat: subcutaneous and visceral.

PATIENTS AND METHODS

Between June 2011. and February 2012., ultrasonographic measurements were performed in 53 obese patients (41 women and 12 men, mean age 40 (+11) years, 22-64 years), who were operated within the next 1-3 days. All ultrasound examinations were performed at the Center of Digestive Radiology and MRI, Clinical Center of Serbia (First Surgical Clinic), with convex US probe, frequency of 3-5 MHz and linear ultrasound probe, frequency of 5-10 MHz, after adequate preparation of the patient (8 hours without a meal). At the same time, basic anthropometric parameters were measured: body mass (m), height (h), body mass index (BMI), waist circumference (WC) and hip circumference (HC) (Table 1).

We measured five diameters of abdominal visceral fat (VAF):

1. IAFT (Intraabdominal Fat Thickness) - distance from the posterior surface of the rectus abdominis muscle to the anterior wall of the aorta, measured 2 cm above the umbilicus (Figure 1A).
2. LV (Lienal Vein) - distance from the posterior surface of the rectus abdominis muscle to the anterior wall of the lienal vein (Figure 1B).
3. VF (Visceral Fat) - distance from the back surface of the visceral surface of the rectus abdominis muscle to the paravertebral muscles, measured at the level of the umbilicus (Figure 2).
4. MES (Mesenterial leafs) - thickness of the three mesenterial leaves (superficial, middle, deep and sum), measured besides the umbilicus (MES 1, 2 and 3 and sum) (Figure 3).
5. MxSFT (Maximal Preperitoneal Fat Thickness) - distance from the white line (linea alba) to the left lobe of the liver, as measured below the xyplophid processus (Figure 4).

We also measured three diameters of the subcutaneous abdominal fat (SCAF):

1. MinSFT (Minimal Subculaneous Fat) - the distance from the surface of the skin to the linea alba, measured below the xyplophid processus (Figure 4).

<table>
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<td>h (m)</td>
<td>1.69±0.14</td>
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<tr>
<td>BMI (kg/m²)</td>
<td>46.4±12.6</td>
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<td>WC (cm)</td>
<td>129±12</td>
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<td>HC (cm)</td>
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<th>TABLE 2</th>
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<tr>
<td>US diameters</td>
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<td>MinSFT (mm)</td>
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<td>MxSFTb (mm)</td>
<td>50±16</td>
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<td>MxSFTc (mm)</td>
<td>31±8</td>
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2 MxSFTa (Maximal Subculaneous Fat Thickness a) - the distance from the surface of the skin to the linea alba, measured 2 cm above the umbilicus.

3 MxSFTb (Maximal Subculaneous Fat Thickness b) - the distance from the surface of the skin to the linea alba, measured 2 cm below the umbilicus.

All patients were operated at the Clinic of Digestive Surgery (First Surgical Clinic), Clinical Center of Serbia. Laparoscopic Roux-and-Y gastric bypass gastroplasty was performed.

Control ultrasonographic examinations were performed following the same protocol as the initial, 1, 3 and 6 months after the surgery in patients who came to the scheduled check-ups.

Statistical analysis was performed using the statistical package SPSS for Windows 17.0. Data obtained by ultrasound measurements are presented in mean and standard deviation, and maximum and minimum value (mean+/SD, M ax, M in), after testing the normality of distribution using the Shapiro-Wilk test. To compare values of the corresponding diameters of visceral and subcutaneous abdominal adipose tissue from the same patient, at the initial and control examination, the paired samples t-test was used (t). Values of p <0.05 were considered statistically significant.
RESULTS

Diameters of the VAF and SCAF those were measured by ultrasonography before the surgery in the whole group of patients (n=53), are summarized in Table 2.

Of the total number of initially examined and operated patients, 28 patients arrived to the control US examination (1, 3, or 6 months after surgery).

Statistically significant decrease in the majority of the anthropometric parameters was registered in the follow-up period of 1, 3 and 6 months after surgery (Table 3, Figure 5, and Figure 6).

Control ultrasound revealed decrease of almost all diameters of the abdominal adipose tissue, which were measured, but statistically significant decrease was found only in some of the diameters of the visceral adipose tissue (Table 4).

DISCUSSION

Diagnostic follow-up of morbidly obese patients before and after bariatric surgery includes monitoring of anthropometric parameters: body weight, BMI, waist, hips, upper arm circumferences, and fat distribution. Computed tomography (CT) is considered the reference method for the accurate quantification of visceral and subcutaneous adipose tissue. However, its use in extremely obese patients is limited. Since most of these patients are young, exposure to the ionizing radiation during the CT scanning is not negligible. It has been reported that CT and US correlate well in measuring the diameters of the abdominal subcutaneous and visceral fat. It was also shown that values of some anthropometric parameters are not reliable indicators for the amount of the visceral fat.

In our series, there was significant decrease in the ultrasonographically measured diameters of visceral abdominal fat, compared to the diameters of the subcutaneous abdominal adipose tissue, in the short follow-up period (1-6 months after the surgery) (Table 4). Weiss et al found in their study, which included 27 patients who were examined by CT six months after bariatric surgery, that the decrease in the abdominal visceral fat was proportional to the decrease in the subcutaneous fat, which means that the VAF/ SCAF index remained approximately unchanged 6 months after the surgery, although the decrease of both the VAF and the SCAF area was proved. We assume that the reason for (statistically) significant decrease of diameters of the visceral abdominal fat, but not of diameters of the subcutaneous fat, which we evaluated in our study, is in fact that the average lengths of the VFA diameters were greater the SCAF diameters (Table 2). Therefore, the differences in lengths of the VFA diameters could easier reach the statistical significance, compared with the SCAF diameters. In support of this hypothesis is the fact that, of all diameters of the subcutaneous fat, only statistically significant reduction of the MaxSCFb was revealed in the follow-up period, probably because the MaxSCFb represents the longest diameter of the subcutaneous abdominal adipose tissue (Tables 2 and 4). It could be
marked that the shortest diameters, which were measured Max PFT and Min SFT, almost did not change at one-month follow-up (Tables 2 and 4). In the study of Sabir et al, authors reported that the highest maximum diameter of the peritoneal adipose tissue was significantly decreased in obese women during a hypocaloric diet regime, which corresponds with MESsum diameter in our study. Therefore, our results are in agreement with the results of the study of Sabir et al, because we have found a statistically significant difference in MESsum after three and six months, compared to the initial values (Table 4). In the study by Wirth et al, the authors found that visceral abdominal fat decreased significantly in men, while in women the amount of subcutaneous fat mostly decreased during the hypocaloric dietary regime. It was not possible for us to do valid comparison of the dynamics of change in diameters of two abdominal fat compartments in relation to the sex in our study, because the patient population was too small.

One drawback of this study was a relatively small number of patients who were followed-up. Second, the US examination were performed by three physicians, which could lead to a certain imprecision in the measurements, especially when using a linear ultrasound probe, because small differences in the degree of compression of linear ultrasound probe result in the difference in the measured diameter of up to several millimeters. Follow-up period was relatively short, so we believe that it would be useful to repeat the US evaluation of parameters of the abdominal fat in all operated patients at least one year after the operation, in order to evaluate the medium-term effects of the bariatric surgery.

CONCLUSION

Based on the initial results that we presented, we can conclude that ultrasound is a useful imaging method in monitoring of obese patients after bariatric surgery in order to exactly quantify the amount and proportion of two different compartments of the abdominal fat: visceral and subcutaneous. We believe that statistically significant decline of some of the US diameters of the visceral abdominal fat in patients who were undergoing bariatric surgery, during the short-term follow-up of 6 months, indicated the therapeutic validity of bariatric surgery in morbidly obese and over-weight patients with associated obesity-related diseases.

SUMMARY

ULTRASONOGRFSKA EVALUACIJA VISCERALNOG I SUBKUTANOG ABDOMINALNOG MASNOG TKIVA PRE I POSLE BARIJATRIJSKE HIRURGIJE

Visceralno masno tkivo se smatra ključnim faktorom u razvoju metaboličkog sindroma i drugih patoloških stanja i oboljenja koja su udružena sa gojaznošću. Zbog toga je pranje dinamike smanjivanja količine visceralnog abdominalnog masnog tkiva značajno u proceni terapijskog efekta različitih modaliteta lečenja gojaznosti, u koje spada i barijatrijska hirurgija. U 53 gojaznih pacijenata ultrazvučno je mereno subkutano i visceralno abdominalno masno tkivo pre i posle barijatrijske operacije, u vremenskom periodu od 1, 3 i 6 meseci. Uštedi su kod istih pacijenata utvrđivani i standardni antropometrijski parametri: telesna masa, BMI, obim struka (OS) i obim kuk-
Statistički značajan pad svih antropometrijskih parametara, osim obima kukova, registrovan je 1, 3 i 6 meseci posle operacije. Kontrolnim ultrazvučnim pregledima registrovano je smanjenje skoro svih dijametara abdominalnog masnog tkiva koji su mereni, ali je statistički značajan pad utvrđen samo za neke od dijametara visceralnog masnog tkiva: IAFT posle 1 i 3 meseca (p=0,031 i p=0,027); VF posle 1 meseca (p=0,031); LV posle 6 meseci (p=0,011); i MEZsum posle 3 i 6 meseci (p=0,001 i p=0,028), kao i za MaxSFTb, posle 1 meseca (p=0,015).

U kratkoročnom periodu praćenja u trajanju od 6 meseci posle barijatrijske operacije, došlo je do značajnog smanjenja telesne mase, BMI i obima struka, a ultrazvučnim pregledima detektovano značajno smanjenje visceralnog abdominalnog masnog tkiva.

Ključne reči: gojaznost, ultrasonografija, masno tkivo, barijatrijska hirurgija.

REFERENCES


