Does abdominal obesity cause increase in the amount of epidural fat?

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Abstract It is known that epidural fat does not alter in obese people. This study aims to find out a possible relationship with epidural fat and abdominal obesity. In this cross-sectional study, 63 patients who were referred to our clinic for lumbar magnetic resonance imaging (MRI) examination were evaluated. Patients with the history of steroid treatment, thyroid disease or Cushing disease were excluded. Waist circumferences (WC), body weight and height were measured and subsequently body-mass index (BMI) was calculated (kg/m^2). On midsagittal T1-weighted images, anterior epidural fat (AEF), posterior epidural fat (PEF) and posterior subcutaneous fat (SCF) thicknesses were measured at the S1 level. The results were compared with age, gender, body weight, height, WC and BMI. There were 31 men and 32 women, age ranged 19–77 years (mean 49). The mean BMI was $29.25 \text{ kg}/\text{m}^2$ (20.7 – 52.7); the mean WC was $97.4 \pm 13.2 \text{ cm}$ (72 – 122) in women and $97.6 \pm 9.8 \text{ cm}$ (72 – 118) in men. Cutoff value of WC was considered as 88 cm for women and 95 cm for men. BMI > 27.5 was considered to be obese. No statistical difference with respect to epidural fat thickness between genders was determined in AEF and PEF ($P = 0.237$, $P = 0.616$). SCF was significantly thicker in women ($P = 0.021$). A very poor and negative correlation was

found between age and PEF ($r = 0.373$, $P = 0.003$), and a very poor and positive correlation between weight and PEF was found ($r = 396$, $P = 0.001$). The thickness of the epidural fat was not differ between obese and nonobese people ($p = 0.571$ for AEF and $p = 0.307$ for PEF). The thickness of the epidural fat was not different in people whose WC was greater than normal values in both gender ($p > 0.05$). Epidural fat is not affected by age, gender, BMI and WC which means that epidural fatty layer. A clear correlation has not been found between epidural fat amount and obesity or abnormal fat distribution yet.

Keywords Fat · Lipomatosis · Magnetic resonance Imaging · Spinal canal

Introduction

Fatty tissue is present in almost every part of the body in various amounts that has some functions such as being energy store and having supportive effect against traumas. Fat layer which is found in the epidural space of spinal canal is not a simple filling tissue. It provides sufficient cushion for the pulsatile movements of the thecal sac, protects nerve structures, facilitates the movement of the dural sac over the periosteum of the spinal column during flexion and extension, and forms a pharmacologic reservoir of lipophilic substances [1, 18, 19].

Obesity, which is one of the most serious health diseases of our age, is formed by the increase of excess energy stored in the fatty tissue of the body. Increase in fat amount can be seen in any part of the body where fatty tissue exists but it is especially seen on the face, neck, body, presacral and episternal areas [6, 9]. A thin fat layer is also seen on the epidural area in the spinal canal [1, 19].

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Epidural lipomatosis (pathologic accumulation of encapsulated fat in the epidural space) is frequently associated with abnormal fat metabolism as Cushing disease or patients receiving steroid therapy or morbid obesity [1, 4–7, 9, 10, 13–15, 19]. Nevertheless, previous reports showed that obesity is unrelated to overall epidural fat [19]. Recently, a relationship between central (android) obesity and the occurrence of epidural lipomatosis was proposed the fact of the abnormal fat distribution [13]. As different from the recent studies, in this study, the relationship between epidural fat thickness and abdominal obesity was investigated.

Materials and methods

The experimental protocol was approved by the Ethical Committee of the Faculty of Medicine at Trakya University.

Patient population

In this cross-sectional study patients who were referred to our university hospital's radiology department for lumbar magnetic resonance imaging (MRI) examination were evaluated. All patients had back or leg pain. Patients with the history of steroid treatment, thyroid disease or Cushing disease were excluded. Waist circumferences (WC) (centimeters), body weight (kilograms) and height (meters) were measured and subsequently body-mass index (BMI) was calculated ($\text{body weight/height}^2$, kg/m^2). Age, gender and BMI of the cases were recorded. BMI > 27.5 was considered to be obese [6, 9]. The cutoff value of WC measurement was considered 95 cm for men, 88 cm for women at which an increased relative risk for Turkish population were previously described [15, 16].

Imaging protocol

Magnetic resonance images were obtained in the sagittal and transverse planes using body coil on a Magnetom 1.0-T unit (Siemens, Impact, Germany). A 256×256 matrix, 28 cm field of view, four excitations and 4 mm section thickness with a 1 mm intersection gap were used. Fast T1 (450–600/10–12; TR/TE) and T2 (3500–7500/100–130; TR/TE), fat saturated T2 (3500/90 TR/TE) and transverse sections were obtained in all patients.

Image analysis

Patients with spinal tumor, infection, trauma, congenital anomaly, scoliosis or previous spinal surgery were

excluded. Also the patients with disc herniations obliterating the epidural fat were not included in the study.

All measurements were done on midline T1-weighted sagittal images by one independent observer. The thickness of anterior, posterior epidural fat pads and posterior subcutaneous fat were measured at S1 proximal end plate. Since anterior epidural fat (AEF) thickness can be affected by the present disc pathologies, measurements were carried at the level of medial platform of vertebral body. The thickness of the anterior epidural fat was measured from the posterior margin of the vertebral body to the anterior margin of the thecal sac; the posterior epidural fat (PEF) thickness was measured from the posterior aspect of the thecal sac to the posterior margin of the spinal osseous canal as described by Wu et al. [1]. The thickness of the posterior subcutaneous fat (SCF) at S1 level was measured from the interspinous ligament to the skin of the back (Fig. 1).

Statistical analyses

Initially, the test distributions were calculated by one-sample Kolmogorov–Smirnov test. All distributions were found normal.

Comparisons between continuous variables were made using Student *t* test. The relation between anterior and posterior epidural fat thickness and age, weight, height, BMI, subcutaneous fat thickness was done using Pearson Correlation analyses. Statistical analysis was carried out using SPSS Ver 13.0 program and significance level was determined as $P < 0.05$.

Fig. 1 T1-weighted (467/12, TE/TR) spin echo midsagittal MRI showing the measurement of AEF (1), PEF (2) and SCF (3) thickness

Results

A total of 63 cases aging between 19 and 77 (mean 49.03 ± 13.5), 32 of which were women and 31 of which were men, were examined. The descriptive values of age, height, WC and BMI in women and men are presented in Table 1. Exactly 46% ($n = 29$) of the cases were non-obese ($\text{BMI} \leq 27.5$) and 54% ($n = 34$) of them were obese ($\text{BMI} > 27.5$).

The thickness of AEF, PEF and SCF are presented in Table 2. SCF was significantly thick in women gender ($P = 0.021$). Poor correlation between PEF and age, body weight and BMI was found. A positive correlation was found between weight, BMI, WC and SCF thickness as expected (Table 3).

The thickness of AEF and PEF did not differ in obese and non-obese groups (Table 4). In men with $\text{WC} < 95$ cm ($n = 13$) mean AEF thickness was 2.38 ± 1.71 mm, mean PEF thickness was 2.69 ± 2.02 mm. In men with $\text{WC} > 95$ cm ($n = 18$) mean AEF thickness was 3.5 ± 2.48 mm, mean PEF thickness was 3.39 ± 1.88 mm. No statistically significant difference was found between two groups ($P = 0.173$ and $P = 0.332$, respectively).

In women group, with $\text{WC} < 88$ cm ($n = 8$), mean AEF thickness was 1.88 ± 1.25 mm, mean PEF thickness was 3.25 ± 1.58 mm. In women with $\text{WC} \geq 88$ cm ($n = 24$) mean AEF thickness was 2.58 ± 2.08 mm, mean PEF thickness was 2.70 ± 2.2 mm. No significant difference found between two groups ($P = 0.374$ and $P = 0.526$, respectively).

Discussion

Epidural lipomatosis is a clinical entity with increase in fatty tissue normally found in the epidural area of lumbar or thoracic spine. This rare entity is usually associated with local or systemic steroid therapy or endocrinopathies such as Cushing's Syndrome and hypothyroidism or morbid obesity [1, 4–7, 9, 10, 13–15, 19]. Idiopathic epidural lipomatosis is extremely rare (7.6%) and the precise etiopathogenesis is still not known [4, 14, 17]. Borre et al. [4] indicated that

Table 1 Some personal characteristics of the respondents

	Women ($n = 32$)	Men ($n = 31$)	<i>P</i> value
Age (years)	52.2 ± 11.8 (31–77)	45 ± 14.6 (19–73)	0.059
Height (m)	1.55 ± 0.07 (1.38–1.70)	1.74 ± 0.06 (1.60–1.90)	0.000
WC (cm)	97.4 ± 13.2 (72–122)	97.6 ± 9.8 (72–118)	0.936
BMI (kg/m^2)	31.0 ± 6.5 (20.7–52.76)	27.4 ± 4.2 (21.0–36.3)	0.012

Table 2 The anterior epidural fat (AEF), posterior epidural fat (PEF), subcutaneous fat (SCF) thickness of the respondents

	AEF (mm)	PEF (mm)	SCF (mm)
Women ($n = 32$)	2.40 ± 1.91	2.84 ± 2.04	31.20 ± 14.9
Men ($n = 31$)	3.03 ± 1.91	3.09 ± 1.9	22.87 ± 12.6
Total ($n = 63$)	2.71 ± 2.08	2.97 ± 1.98	27.08 ± 14.4
<i>P</i> value	0.237	0.616	0.021

Table 3 The correlations between AEF, PEF and SCF and personal characteristics of the patients

	Age	Body weight	Height	BMI	WC
AEF					
<i>r</i>	−0.115	0.307	0.201	0.151	0.15
<i>P</i>	0.369	0.015	0.113	0.237	0.241
PEF					
<i>r</i>	−0.373 ^b	0.396 ^b	0.171	0.281 ^a	0.16
<i>P</i>	0.003	0.001	0.18	0.026	0.209
SCF					
<i>r</i>	0.061	0.484 ^b	−0.247	0.683 ^b	0.507 ^b
<i>P</i>	0.635	0.00	0.051	0.00	0.00

^a correlation is significant at 0.05 level

^b correlation is significant at 0.001 level

Table 4 The AEF and PEF thickness of obese and non-obese patients

	Non-obese ($n = 29$)	Obese ($n = 34$)	<i>P</i> value
AEF Mean $\pm$ SD (mm)	2.55 ± 1.88	2.85 ± 2.25	0.571
PEF Mean $\pm$ SD (mm)	2.69 ± 1.81	3.20 ± 2.11	0.307

86.6% of lipomatosis cases are obese ($\text{BMI} > 27.5$). In the epidural lipomatosis cases that are seen with obesity, epidural fat can be reduced by low calorie diets [5, 13]. But the significant existence of obesity in advanced lipomatosis cases was not determined yet. Maillot et al. [13] claimed that epidural lipomatosis can be especially found in cases with central adiposity, lipid metabolism abnormalities and insulin resistance in their case report. It is stated that central fat distribution is a common characteristic in all cases of epidural lipomatosis. The described obesity phenotype is also characteristic of Cushing disease or in long-term glucocorticoid treatment [13].

BMI is the most widely used method to show the increase in fat amount in the whole body. Nevertheless, BMI does not reliably reflect the body fat composition [6, 9]. Measurement of WC is a simple anthropometric measure and a good indicator of central obesity. The measurement of WC provides information about the

distribution of body fat and is a measure of risk for conditions such as coronary heart disease. It is now well known that people who carry their excess fat centrally (within the abdominal cavity) are more likely to suffer the consequences of being overweight [6, 15, 16, 19]. As we expected, we found out that subcutaneous fatty tissue was thicker in obese cases ($P < 0.01$).

MRI of the lumbar spine is an excellent modality to visualize the bony canal and the spinal soft tissues and is able to detect fat. Having a linear measurement of the fat amount, a quantitative value was found for the fat amount [4].

A study similar to ours has been previously done by Wu et al. [19]. The positive correlation between BMI and subcutaneous fatty tissue, and the result that shows epidural fat thickness is not correlated to height, BMI and gender were the common findings of both studies. When genders were considered, epidural fat was thicker in men but there was not statistical significant difference.

The result showing that PEF thickness has a positive correlation with body weight can also be considered a similar finding in both studies. As a different result, we found that with aging, PEF is getting thin ($r = 0.373$, $P = 0.003$), but AEF does not change ($r = 0.115$, $P = 0.369$). In the above-mentioned study, it was found that AEF is thicker in young people ($r = 0.22$, $P = 0.024$) but there was no difference in PEF ($r = 0.01$, $P = 0.954$). Herzog et al. [10] identified posterior compression of the thecal sac by epidural fat that with acquired stenosis secondary to facet arthrosis. They did not observe this finding in patients with stenosis secondary to anterior column pathology or in patients with developmentally large facets. As we did not evaluate the spinal stenosis we cannot correlate the amount of epidural fat with spinal stenosis.

In our study, we found out that epidural fatty tissue is not correlated with BMI ($P = 0.571$ for AEF and $P = 0.307$ for PEF) like previous study [19].

Somewhat unexpectedly, we did not find a relation between WC and epidural fat. In men whose WC were greater than the normal values, AEF and PEF were thicker; in women whose WC greater than the normal values, only AEF was thicker, but these differences were not statistically significant. On the other hand, PEF thickness was smaller in women with thicker waist. There have been no prior studies that we are aware of evaluating the effect of abdominal obesity on epidural fat. More studies are suggested to be done on body fat distribution also immunohistochemical examinations on this issue is needed in lipomatosis cases.

The limitation of the current study is that the intra- and inter-observer variations were not investigated.

As a conclusion, it can be stated that spinal epidural fatty tissue is not affected by BMI and abdominal obesity. That means epidural fatty layer does not have a function in fat storage of the body. The role played by the normal

epidural fat in lumbar canal stenosis is still less well known.

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