Title

Gender differences in subcutaneous and perirenal fat distribution

Journal

Surgical and Radiologic Anatomy, 32(9)

ISSN

0930-1038

Authors

Eisner, Brian H
Zargooshi, Javaad
Berger, Aaron D
et al.

Publication Date

2010-11-01

DOI

10.1007/s00276-010-0692-7

Peer reviewed

Surg Radiol Anat (2010) 32:879–882
DOI 10.1007/s00276-010-0692-7

ORIGINAL ARTICLE

Gender differences in subcutaneous and perirenal fat distribution

Brian H. Eisner · Javaad Zargooshi · Aaron D. Berger · Matthew R. Cooperberg · Sean M. Doyle · Sonali Sheth · Marshall L. Stoller

Received: 5 May 2009 / Accepted: 24 June 2010 / Published online: 4 July 2010

Abstract

Purpose Body mass index (BMI) has been shown to influence the outcome of various surgical procedures. The purpose of this study is to assess the relationship between BMI, gender, and the distribution of subcutaneous and perirenal fat.

Methods A retrospective review was performed for 123 patients who underwent radical or partial nephrectomy. Preoperative CT scans were reviewed by two independent observers. Subcutaneous fat was measured at three locations and perirenal fat was measured at six locations. Statistical analysis was performed using the Student's *t* test and the Pearson's correlation coefficient.

Results Mean anterior subcutaneous fat was significantly greater in females than in males (2.54 vs. 1.78 cm, $p < 0.001$) as was mean right posterolateral subcutaneous fat (2.78 vs. 2.21 cm, $p = 0.03$). With regard to perirenal fat, men were greater than women for all perirenal locations around the left kidney. For the right kidney, men were greater than women for four out of six perirenal positions. In both men and women, BMI was strongly correlated with subcutaneous fat. However, BMI was weakly correlated with perirenal fat.

Conclusions Women exceed men in subcutaneous fat, while men exceed women in perirenal fat. Obese patients are very likely to have large amounts of subcutaneous fat, but will not necessarily have proportionally increased fat around their kidneys when compared to the patients with lower BMI. These differences may have important implications for surgical approaches to the kidney.

Keywords Fat · Distribution · Nephrectomy · Perirenal · Subcutaneous

B. H. Eisner (✉)
Department of Urology, GRB 1102, Massachusetts General Hospital, 55 Fruit Street, Boston, MA 02114, USA
e-mail: beisner@partners.org

J. Zargooshi · A. D. Berger · M. R. Cooperberg · S. M. Doyle · S. Sheth · M. L. Stoller
Department of Urology, University of California-San Francisco, San Francisco, CA, USA

Introduction

Measurements of total body fat, body mass index (BMI), and visceral fat have been shown to correlate with operative times in laparoscopic urologic surgery [1, 2]. With respect to prostate surgery, increasing BMI appears to be associated with longer operative times, but not with increased complications or other adverse outcomes [2]. BMI is useful for describing general populations, but it is not helpful for preoperative planning due to variations in muscle mass and fat distribution among patients [5]. While a correlation between BMI and internal fat seems intuitive, no studies have described such a relationship. The amount of subcutaneous fat and perinephric fat are important when planning surgical approaches to the kidney. A single study has been published examining the relationship between perirenal fat (i.e., fat surrounding the kidneys) and operative outcomes of renal surgery. In the study of laparoscopic donor nephrectomy, a significant correlation between operative times and both anterior and posterior perirenal fat was found [1]. Multivariate analysis in that study revealed that in donor nephrectomy, anterior perirenal fat accounted for 20% of the variance in operative time. Interestingly, there are no other studies in the literature that have systematically examined subcutaneous and perirenal fat distribution as it may pertain to renal surgery. Based on our previous experiences, we hypothesize that women have greater subcutaneous fat and less perirenal fat than men. The current study was undertaken to examine gender differences existing in fat distribution and to better understand the relationship between BMI and fat distribution.

Materials and methods

A retrospective review was performed for 123 patients who underwent laparoscopic radical or partial nephrectomy at our institution and had preoperative computed tomography (CT) scans. Information on age, gender, height, weight, renal pathology, renal tumor size, and Furhman grade was collected. All CT scans were performed in the supine position and were analyzed by two independent observers (board certified radiologist, board certified urologist). CT measurements were performed on axial images at the level of the renal vein for each kidney. Subcutaneous fat was defined as the distance from skin to body musculature and three subcutaneous measurements were taken (anterior, posterior, and right posterolateral). Perirenal fat was defined as the distance from kidney to nearest viscera or muscle and six perirenal measurements were taken (anterior, medial, posterior, lateral, anterolateral, and posterolateral). Figure 1 demonstrates the measurement positions on a representative CT scan. Differences in fat measurements for each position and gender were analyzed using the Student's *t* test. Pearson's coefficient was used to examine BMI and fat distribution. We certify that all applicable institutional and governmental regulations concerning the ethical use of human volunteers/animals were followed during this research. When interpreting strength of correlation, standard accepted definitions of weak (0.1–0.3), moderate (0.3–0.5), and strong (0.5–1.0) were used.

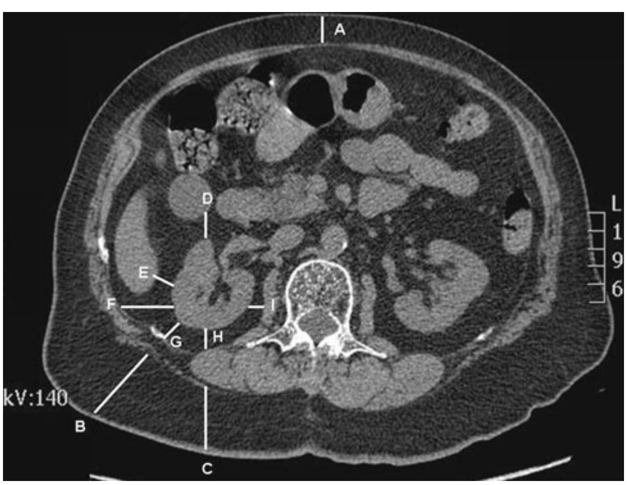

Fig. 1 Measurement locations: anterior subcutaneous (*A*), posterolateral subcutaneous (*B*), posterior subcutaneous (*C*), anterior perirenal (*D*), anterolateral perirenal (*E*), lateral perirenal (*F*), posterolateral perirenal (*G*), posterior perirenal (*H*), medial perirenal (*I*)

Results

One hundred and twenty-three patients were analyzed. Female-to-male ratio was 58:65. BMI was calculated for 49 women and 43 men—there was no difference between females and males (28.9 vs. 28.8 kg/m^2, p = NS). There was no difference in age between men (mean 60.0 years, SD 17.7) and women (mean 59.0, SD 14.1; $p = 0.8$). Nineteen patients had a solitary kidney and therefore only had unilateral measurements. Specimen pathology was as follows: 82 patients with renal cell carcinoma (66.7%), and 41 patients (33.3%) with benign lesions or infectious conditions. Among the 82 patients with renal cell carcinoma, tumor stage was as follows: T1a (64.6%), T1b (20.7%), T2 (3.7%), T3 (6.1%), and T4 (4.9%).

Subcutaneous fat

Mean anterior subcutaneous fat was significantly greater in females than in males (2.54 vs. 1.78 cm, $p < 0.001$) as was mean right posterolateral subcutaneous fat (2.78 vs. 2.21 cm, $p = 0.03$). Mean posterior subcutaneous fat was greater in females than in males, and this was nearly statistically significant (2.69 vs. 2.20 cm, $p = 0.06$). Among women, there was no difference between anterior and posterior subcutaneous fat (2.54 vs. 2.69, p = NS), but for men, anterior fat was significantly less than posterior fat (1.78 vs. 2.20 cm, $p = 0.05$). These results are shown in Table 1.

In women, there was a moderate correlation between BMI and anterior subcutaneous fat ($r = 0.52$, $p < 0.001$), and a strong correlation between BMI and posterior subcutaneous fat ($r = 0.82$, $p < 0.001$) and BMI and right posterolateral subcutaneous fat ($r = 0.73$, $p < 0.001$). In men, BMI was moderately correlated with anterior subcutaneous fat ($r = 0.47$, $p = 0.003$) and strongly correlated with posterior subcutaneous fat ($r = 0.84$, $p < 0.001$) and right posterolateral subcutaneous fat ($r = 0.84$, $p < 0.001$). These results are shown in Table 2.

Perirenal fat

Perirenal fat was greater in men than in women for all perirenal locations around the left kidney (anterior $p = 0.01$, medial $p = 0.002$, posterior $p = 0.001$, lateral $p = 0.002$, anterolateral $p = 0.03$, and posterolateral $p = 0.003$). For the right kidney, perirenal fat in men was

Table 1 Differences in subcutaneous fat between females and males

	Females	Males	p value
Anterior subcutaneous fat (cm)	2.54 (0.82–6.57)	1.78 (0.15–4.30)	<0.001
Posterior subcutaneous fat (cm)	2.69 (0.49–7.33)	2.20 (0.52–7.72)	0.06
Posterolateral subcutaneous fat (cm)	2.78 (0.73–6.58)	2.21 (0.37–7.92)	0.03
	Anterior subcutaneous fat (cm)	**Posterior subcutaneous fat (cm)**	**p value**
Females	2.54 (0.82–6.57)	2.69 (0.49–7.33)	NS
Males	1.78 (0.15–4.30)	2.20 (0.52–7.72)	0.05

Table 2 Pearson's correlation between BMI and fat measurements

Location	Men		Women	
	r	p value	r	p value
Subcutaneous fat				
Anterior	0.47	0.003	0.52	<0.001
Posterior	0.84	<0.001	0.82	<0.001
Right posterolateral	0.84	<0.001	0.73	<0.001
Left perirenal fat				
Posterior	0.26	NS	0.18	NS
Posterolateral	0.21	NS	0.33	0.02
Lateral	0.31	0.05	0.30	0.04
Anterolateral	0.34	0.04	0.29	NS
Anterior	0.36	0.03	0.34	0.04
Medial	0.14	NS	0.38	0.01
Right perirenal fat				
Posterior	0.14	NS	0.37	0.02
Posterolateral	0.21	NS	0.29	NS
Lateral	0.23	NS	0.23	NS
Anterolateral	0.17	NS	0.08	NS
Anterior	0.24	NS	0.48	0.004
Medial	0.22	NS	0.44	0.007

Table 3 Differences in perirenal fat between females and males

	Females	Males	p value
Right			
Anterior	0.96 (0.24–2.18)	1.37 (0.28–3.02)	0.01
Medial	1.54 (0.23–4.87)	2.04 (0.15–4.32)	0.01
Posterior	1.22 (0.24–3.38)	1.85 (0.18–7.10)	0.003
Lateral	2.23 (0.22–6.42)	2.47 (0.28–6.83)	NS
Anterolateral	1.04 (0.20–6.65)	1.35 (0.35–3.67)	NS
Posterolateral	1.50 (0.16–4.75)	2.21 (0.30–7.63)	0.001
Left			
Anterior	1.00 (0.21–4.12)	1.38 (0.31–2.60)	0.01
Medial	1.77 (0.57–4.64)	2.28 (0.65–4.45)	0.002
Posterior	1.38 (0.18–5.00)	2.11 (0.25–6.19)	0.001
Lateral	2.40 (0.30–5.83)	3.16 (0.73–6.08)	0.002
Anterolateral	1.49 (0.39–3.73)	1.89 (0.36–3.89)	0.03
Posterolateral	1.57 (0.29–5.07)	2.15 (0.39–5.12)	0.003

greater than in women for four out of six positions (anterior $p = 0.009$, medial $p = 0.01$, posterior $p = 0.003$, and posterolateral $p = 0.001$) and there was no difference for the remaining two positions (lateral $p =$ NS, and antero-lateral $p =$ NS). These results are shown in Table 3.

In women, there was a weak correlation between BMI and the following perirenal fat positions: left postero-lateral, left lateral, left anteriolateral, left medial, and right posterior. A moderate correlation between BMI and right anterior and right medial perirenal fat was also found in women. The remainder of the perirenal fat locations in women were not correlated with BMI. In men, BMI was weakly correlated with perirenal fat in the left lateral, left anterolateral, and left anterior positions. The remainder of the perirenal fat positions in men were not correlated with BMI. These results are shown in Table 2.

Discussion

Several studies have examined the impact of BMI on urologic procedures. BMI as well as fat distribution affects the outcome of extracorporeal shock wave lithotripsy (ESWL). In two studies, increasing BMI and increasing stone-to-skin distance were shown to decrease success of ESWL treatment for renal stones [8, 9]. Increasing BMI has also been shown to increase operative times during laparoscopic radical prostatectomy [2].

Recently, Anderson and colleagues [1] published the first study examining the relationship between abdominal fat, perinephric fat, and operative times in laparoscopic donor nephrectomy. The study found that, of BMI's abdominal fat, and perirenal fat, only perirenal fat correlated with operative times. On multivariate analysis, perirenal fat accounted for 20% of the variance in operative time. They also found that men had greater perirenal fat while women had greater abdominal fat [1]. To our knowledge, there are no other studies in the literature which examine the relationship between BMI, gender, and fat distribution with specific relevance to the kidneys.

We undertook the current study to provide further anatomic evidence of the differences between men and women with regard to fat distribution. Our study confirmed the findings of Anderson and colleagues, as well as other studies, which have demonstrated significant differences in body fat distribution between men and women [1, 4, 7]. We found that women had 43% greater anterior subcutaneous fat, 26% greater posterolateral subcutaneous fat than men and 22% greater (nearly statistically significant) posterior subcutaneous fat than men. When measuring perirenal fat, 10 out of 12 positions examined were significantly greater in men while the two others were similar between females and males. This corresponded to a mean of 36% greater perinephric fat for men when compared to women at each perinephric location. One important distinction between our study and that of Anderson is that they examined patients undergoing laparoscopic donor nephrectomy (i.e., healthy patients without renal pathology) [1]. We examined patients with malignant or inflammatory lesions who presented for surgery. It follows, then, that gender differences in perinephric fat distribution are applicable in the planning of both donor nephrectomy as well as oncologic and extirpative renal surgery.

As expected, BMI was strongly correlated with subcutaneous fat for both women and men and these correlations were all statistically significant. These findings are consistent with previous reports which have demonstrated the relationship between abdominal girth and/or subcutaneous fat and BMI [5, 6]. On the other hand, the relationship between BMI and perirenal fat was minimal. Weak correlations existed for men and women for less than half of the perirenal locations, and the remainder showed no correlation between BMI and perirenal fat. In other words, obese patients are very likely to have large amounts of subcutaneous fat, but will not necessarily have proportionally increased fat around their kidneys when compared to patients with lower BMI.

There are several inherent weaknesses in our study. This study is retrospective, and the results are subjected to the shortcomings of a non-prospective study. For this reason, we also did not observe changes in fat distribution over time—a prospective, long-term study would be helpful in determining how fat distribution changes with weight gain and/or weight loss. Although we believe that subcutaneous and perinephric fat could have important implications in renal surgery, we did not examine clinical outcomes of these surgeries in this anatomic study. Future studies are necessary to determine whether operative outcomes for renal surgery are related to our anatomic findings. We also examined patients with renal tumors, which theoretically could alter fat distribution. In kidneys which contained tumor, we took measurements from the renal parenchyma as described in "Methods" in an attempt to avoid this possible confounding factor. Finally, we acknowledge that despite our use of standard accepted designations for strength of correlation, some authors argue that the designations of weak, moderate, and strong correlation are "arbitrary." Nonetheless, we report correlations with statistical significance of $p < 0.05$ and feel that our reported correlations are consistent with other interpretations of this statistical test in the literature [3].

In conclusion, our study demonstrated significant gender differences in distribution of subcutaneous and perirenal fat between women and men. Specifically, women exceed men in subcutaneous fat, while men exceed women in perirenal fat. In addition, obese patients are very likely to have large amounts of subcutaneous fat, but will not necessarily have proportionally increased fat around their kidneys when compared to patients with lower BMI. These differences may have important implications for surgical approaches to the kidney.

Conflict of interest statement Brian Eisner is a speaker for Boston Scientific Corporation and a consultant for the Ravine Group and PercSys. Marshall Stoller is a consultant for the Ravine Group and PercSys. Matthew Cooperberg is a consultant for Abbott. All other authors have no disclosures.

References

1. Anderson KM, Lindler TU, Lamberton GR, Baron PW, Ojogho OK, Baldwin DD (2008) Laparoscopic donor nephrectomy: effect of perirenal fat upon donor operative time. J Endourol 22(10):2269–2274
2. Brown JA, Rodin DM, Lee B, Dahl DM (2005) Laparoscopic radical prostatectomy and body mass index: an assessment of 151 sequential cases. J Urol 173:442–445
3. Cohen J (1988) Statistical power analysis for the behavioral sciences. Routledge Academic, New York
4. Ferrara CM, Goldberg AP, Nicklas BJ, Sorkin JD, Ryan AS (2008) Sex differences in insulin action and body fat distribution in overweight and obese middle-aged and older men and women. Appl Physiol Nutr Metab 33:784–790
5. Friedl KE (2004) Can you be large, not obese? The distinction between body weight, body fat, abdominal fat in occupational standards. Diabetes Technol Ther 6:732–749
6. Hamdy O, Porramatikul S, Al-Ozairi E (2006) Metabolic obesity: the paradox between visceral and subcutaneous fat. Curr Diabetes Rev 2:367–3739
7. Lemieux S, Prud'homme D, Bouchard C, Tremblay A, Despres JP (1993) Sex differences in the relation of visceral adipose tissue accumulation to total body fatness. Am J Clin Nutr 58:463–467
8. Pareek G, Hedican SP, Lee FT Jr, Nakada SY (2005) Shock wave lithotripsy success determined by skin-to-stone distance on computed tomography. Urology 66:941–944
9. Pareek G, Armenakas NA, Panagopoulos G, Bruno JJ, Fracchia JA (2005) Extracorporeal shock wave lithotripsy success based on body mass index and Hounsfield units. Urology 65:33–36