MRI of intra-abdominal fat and HIV-associated lipodystrophy: a case review

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Résumé
IRM du tissu adipeux abdominal et lipodystrophie VIH, étude cas-témoin

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Objectifs : Caractériser par une méthode d’imagerie reproductible les redistributions adipeuses abdominales chez les patients infectés par le virus de l’immunodéficience humaine (VIH) cliniquement lipodystrophiques.

Matériels et méthodes : 89 patients VIH cliniquement lipodystrophiques ont été inclus dans l’étude. Une seule coupe axiale abdominale pondérée T1 passant par le milieu du corps de la quatrième vertèbre lombaire (L4) est réalisée en apnée. Deux radiologues mesurent de façon semi-automatique les surfaces de tissu adipeux abdominales dans les régions sous-cutanées (SAT) et viscérales (VAT). Les mesures sont comparées à celles de témoins appariés (ethnie, sexe, âge et indice de masse corporelle).

Résultats : Les mesures de surfaces adipeuses abdominales en IRM sont reproductibles. Chez l’homme lipodystrophique : on décrit trois formes cliniques de lipodystrophie avec augmentation du tissu adipeux viscéral (VAT) et diminution du tissu graisseux sous cutané (SAT) par rapport aux sujets sains. Chez les femmes, on retrouve deux formes cliniques de lipodystrophie avec une augmentation du VAT mais aucune diminution du SAT.

Conclusion : L’IRM avec comparaison malades-témoins appariés est une méthode reproductible pour caractériser les redistributions adipeuses de la lipodystrophie et en évaluer la sévérité. Un large référentiel IRM de distribution du tissu adipeux abdominal sur témoins serait utile à l’étude des pathologies métaboliques.


Abstract

Purpose. To characterize intra-abdominal adipose tissue changes in HIV patients with clinical lipodystrophy using a reproducible imaging technique.

Materials and methods. 89 HIV patients with clinical lipodystrophy were included. A single axial T1W image was acquired at the mid L4 vertebral level. Two radiologists measured subcutaneous (SAT) and visceral (VAT) adipose tissues using a semi-automated method. Measurements were compared to a matched population (race, sex, age and BMI).

Results. Measurements of abdominal adipose tissue on MRI are reproducible. Three clinical types of lipodystrophy are described in males with increased visceral (VAT) and reduced subcutaneous (SAT) adipose tissues compared to control subjects. Two clinical types of lipodystrophy are described in females with increased visceral (VAT) and unchanged subcutaneous (SAT) adipose tissues.

Conclusion. MRI with comparison between HIV patients and normal control subjects is a reproducible method to characterize adipose tissue changes of lipodystrophy and evaluate its severity. Evaluation of a adipose tissue distribution in a large control population would be helpful to the study of metabolic disorders.

Key words: Lipodystrophy. HIV. Adipose tissue. Abdomen. MRI.


Highly active antiretroviral therapy (HAART) has revolutionized the prognosis of HIV infection (1). However, the use of such treatment regimen has coincided with the emergence of adipose tissue distribution modifications possibly related to anomalies of lipid and glucose metabolism. These modifications have been grouped under the category of lipodystrophies because of analogies with rarer congenital lipodystrophies such as lipoatrophic diabetes (2). Lipodystrophy may correspond to peripheral subcutaneous fat wasting of the face, limbs and/or buttocks (3) with fat accumulation at the abdomen (4), breasts (5) or back of neck (6). Clinical presentation may be quite variable with pure lipoatrophic types, pure lypoatrophic types or mixed types (7).

The association of individual antiretroviral agents in the development of lipodystrophy has been progressively established (4, 8-12). New agents without association to lipodystrophy have been introduced and new combination therapies proposed (13-17). Unfortunately for patients previously treated with drugs associated with lipodystrophy, especially some of the nucleoside analogs (AZT, D4T, DDI, DDC), the anomalous fat redistribution seems poorly reversible and persistent with esthetic, psychological and metabolic repercussions (18-20). A number of patients are still treated with these drugs to achieve an effective...
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Antiretroviral therapy or, in some countries, due to financial reasons. New therapeutic regimens for lipodystrophy are currently being developed and their evaluation will require accurate and reproducible means of measuring the distribution of adipose tissues (21, 22).

Lipodystrophy is a clinical diagnosis, based on subjective assessment by the patient and clinician. It is difficult to evaluate the severity of abdominal fat redistribution because of lack of agreement on a definition (23) and anthropometric measurements remain approximate. However, appreciation of the degree of adipose tissue redistribution to the subcutaneous (SAT) and abdominal visceral (VAT) regions is important because the ratio between visceral and subcutaneous adipose tissue correlates to the cardiovascular risk for the non-HIV population. Follow-up over time of the pattern of adipose tissue redistribution is mandatory to assess the efficacy of specific treatments.

The purpose of this study was to evaluate the reproducibility of a non-irradiating imaging technique that could be performed on patients and control subjects irrespective of age.

Another objective was to determine if the imaging technique could confirm the presence of abnormal adipose tissue redistribution in patients with clinical suspicion of lipodystrophy and characterize the different clinical types in male and female patients. In this prospective study, the abdominal fat was measured on MRI in female and male patients and control subjects.

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Materials and methods

Patient population

Prospective study including 89 consecutive patients, aged 32-62 (21 females, 68 males). The protocol for patients and control subjects was approved by the local ethics committee. All HIV infected patients were treated using 2 nucleoside inhibitors and 1 protease inhibitor. All showed clinical findings of lipodystrophy, ie, signs of peripheral lipodystrophy and/or signs of central adipose tissue accumulation. Diagnostic criteria for lipodystrophy were determined by members of the infectious diseases department from our institution and were based on clinical consensus of 2 physicians and the patient. Lipodystrophy was characterized by emaciated face with loss of retro-auricular fat pads, subcutaneous limb atrophy, loss of buttock profile, and unusual conspicuity of subcutaneous veins (24). Lipohypertrophy or truncular adipose deposition was characterized by a buffalo hump, breast enlargement, abdominal or truncular obesity. Abdominal hypertrophy was defined by a waist-hip ratio >0.9 for males or 0.85 for females. Each patient was matched with a control subject according to race, age, sex and body mass index (BMI). Overall, patients were all Caucasians, same sex, same age ±5 years, same weight ±2 kg, same height ±3 cm. Control subjects were selected from a pool of 200 volunteers without HIV infection of metabolic disorder. They were either on staff at our facility, and without contraindication to MR imaging, or patients who underwent lumbar spine MRI for back pain. Informed consent was obtained from all patients and control subjects.

Anthropometric measurements

All subjects underwent physical examination with weight (±100 g), height, hip size (±0.5 mm) and waist/hip ratio measurement. BMI was calculated using the weight divided by the square of the height.

MRI evaluation of adipose and muscle tissue distribution (fig. 1)

MRI examinations were performed using a 0.5T MR unit (MRMax, General Electric, Milwaukee, WI). A 7 mm thick axial spin echo T1W (TR 150 ms, TE 20 ms, FOV 35 or 42 cm, matrix 128x256) image through the mid L4 vertebra was obtained in all subjects during breath hold. This level was selected because it is most frequently cited in the literature and because it provides a good evaluation of visceral fat since it is at a level below the liver. Measurements of fat surface areas were performed at a workstation by two experienced radiologists. Surface measurements were automated following manual mapping of regions of interest (ROI) on each section. The distribution of subcutaneous (SAT), visceral (VAT) and total (TAT) or VAT + SAT fat was calculated (fig. 1).

Interobserver reproducibility was assessed in 105 patients (lipodystrophic patients and control subjects). Intraobserver reproducibility was assessed in 50 patients (lipodystrophic patients).

![Fig. 1: Example of a T1W MR image through the L4 vertebra. Regions of interest for subcutaneous (1a) and visceral (1b) adipose tissue. SAT: subcutaneous adipose tissue; VAT: visceral adipose tissue; TAT: total adipose tissue.](image-url)
Statistical analysis
Results were reported as mean values ± standard deviation. Statistical analysis for small samples was performed with the Student t test and statistical analysis for large samples was based on the reduced central limit theorem. A p value <0.05 was considered significant.

Results
Patient population
The mean age was 44.3±7.6 years for males and 43.2±8.1 years for females. The mean BMI was 23.21±2.23 in males and 22.56±2.93 in females.

Measurement reproducibility
Inter-observer reproducibility was assessed for 105 patients. The maximum variation was 2.19% for adipose tissues (2.19% and 1.21% for SAT and VAT respectively) (table I).

Intra-observer reproducibility was assessed for 50 patients and was inferior to 1% for adipose tissues (0.96% and 0.84% for SAT and VAT respectively) (table II).

In addition, the same examination was repeated 5 times for 11 patients to determine if measurements were reproducible on different acquisitions. The mean difference for measurements was less than 1.5 cm² from one acquisition to the other for a same patient (1.18 cm² and 1.35 cm² for SAT and VAT respectively).

Characteristics of abdominal adipose tissue redistribution in lipodystrophic HIV patients compared to control subjects (table III)

Lipodystrophic patients showed a significant increase of visceral adipose tissue (VAT: 137.97 cm²±57.26) compared to matched control subjects (VAT: 109.36 cm²±61.71) (p<0.01) and a significant reduction of subcutaneous adipose tissues (SAT: 89.85 cm²±66.2) compared to matched control subjects (SAT: 122.7 cm²±73.63) (p<0.01) (VAT/TAT: 0.62±0.15 versus VAT/TAT: 0.48±0.1; p<0.01).

Clinically lipodystrophic females showed a significant increase of visceral adipose tissue (VAT: 160.61 cm²±52.3) compared to matched control subjects (VAT: 60.8 cm²±47.21) (p<0.03) without significant difference of subcutaneous adipose tissues (SAT: 164.28 cm²±52.08) compared to matched control subjects (SAT: 149.05 cm²±69.53) (p>0.05). The SAT appeared slightly increased compared to control subjects, but without being statistically significant.

The standard deviation numbers are elevated because of the wide age range of our population: 32-62 years old with BMI range of 16.5-34.4.

<table>
<thead>
<tr>
<th>Table I</th>
<th>MRI Measurements: Inter-observer reproducibility.</th>
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<tr>
<td>Measures en IRM : Reproductibilité inter-observateur.</td>
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<tr>
<td>Mean ± standard deviation</td>
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<td>SAT</td>
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<td>VAT</td>
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<th>Table II</th>
<th>MRI Measurements: Intra-observer reproducibility.</th>
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<td>Measures en IRM : Reproductibilité intra-observateur.</td>
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<tr>
<td>Mean ± standard deviation</td>
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<th>Table III</th>
<th>Abdominal adipose tissue: Summary of results.</th>
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<td>Tissu adipeux abdominal : Synthèse des résultats.</td>
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<tr>
<td>Patients</td>
<td>Control subjects</td>
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<tr>
<td>Males n=68</td>
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<tr>
<td>SAT (cm²)</td>
<td>89.85±66.2</td>
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<tr>
<td>VAT (cm²)</td>
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<td>TAT (cm²)</td>
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<td>Females n=21</td>
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<tr>
<td>SAT (cm²)</td>
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<tr>
<td>VAT (cm²)</td>
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<td>TAT (cm²)</td>
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<td>SAT (cm²)</td>
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<tr>
<td>VAT (cm²)</td>
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<tr>
<td>TAT (cm²)</td>
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<td>VAT/TAT</td>
<td>0.57±0.18</td>
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</table>

S: Significant difference (p<0.05). NS: Non-significant difference (p>0.05).
Characteristics of abdominal adipose tissue redistribution for each clinical type (Table IV)

In our study, all 3 clinical types of lipodystrophy occurred in our male patients: 21 were clinically lipatrophic (31%), 15 showed abdominal-truncular obesity or lipohypertrophy (22%) and 32 had mixed lipodystrophy (47%). In males with pure lipatropy presenting with emaciated face, atrophic limbs and absence of abdominal obesity, MRI confirmed a significant reduction of abdominal subcutaneous adipose tissues (SAT: 39.2 cm²±14.2) compared to control subjects (SAT: 77.73 cm²±33.1) without significant modification of visceral adipose tissues (VAT: 76.93 cm²±29.5) in patients versus VAT: 77.13 cm²±27.4 in control subjects; (p>0.05). In females with pure lipohypertrophy, MRI confirmed a significant increase of abdominal visceral adipose tissues (VAT: 124.5 cm²±60.4) compared to control subjects (VAT: 63.91 cm²±33.9) without significant modification of subcutaneous adipose tissues (SAT: 175 cm²±75 in patients versus SAT: 156.58 cm²±72.4 in control subjects; p>0.05). In males with mixed lipodystrophy, MRI confirmed a significant increase of abdominal visceral adipose tissues (VAT: 85.25 cm²±27.1) compared to control subjects (VAT: 56.5 cm²±26.8) but no reduction of subcutaneous adipose tissues (SAT: 145.25 cm²±20.3 in patients versus SAT: 125.62 cm²±59.2 in control subjects). Similar to pure lipohypertrophic types, the SAT appeared slightly increased compared to control subjects, but without being statistically significant (fig. 6).

<table>
<thead>
<tr>
<th>Table IV</th>
<th>Characterization of different types of lipodystrophy.</th>
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| Tableau IV | Caractérisation des différentes formes de lipodystrophie. |

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<th>Meas</th>
<th>LIPAATROPHY</th>
<th>LIPOHYPERTROPHY</th>
<th>MIXED</th>
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<td>Patients Controls</td>
<td>p</td>
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<tr>
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<td></td>
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<tr>
<td>SAT (cm²)</td>
<td>39.2</td>
<td>±14.2</td>
<td>77.73</td>
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<td>VAT (cm²)</td>
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<td>±29.5</td>
<td>77.13</td>
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<td>TAT (cm²)</td>
<td>116.13</td>
<td>±37.4</td>
<td>154.8</td>
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<td>VAT/TAT</td>
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<td>±0.08</td>
<td>0.50</td>
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<td>Females</td>
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<tr>
<td>SAT (cm²)</td>
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<td>VAT (cm²)</td>
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<tr>
<td>TAT (cm²)</td>
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<tr>
<td>VAT/TAT</td>
<td>0.41</td>
<td>±0.15</td>
<td>0.36</td>
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</table>

S: Significant difference (p<0.05); NS: Non-significant difference (p>0.05).

Discussion

Our results demonstrate that a single axial T1W MR image at the L4 level can depict subcutaneous and visceral adipose tissue distribution in HIV infected patients and differentiate this distribution from matched control subjects. Results were reproducible allowing follow-up of lipodystrophic HIV patients. This method could differentiate pure lipatrophy from pure lipohypertrophic types and showed that differences existed between males and females with subcutaneous atrophy being less frequent in females.

There currently is no agreement on a definition of lipodystrophy and its diagnosis remains based on a subjective clinical assessment (23). Diagnosis and evaluation are difficult because pure lipatrophic, pure lipohypertrophic and mixed types exist. Peripheral lipatropy is characterized by wasting of subcutaneous adipose tissues providing patients with “athletic” features (3). The face is emaciated with loss of Bichat’s and peri-auricular fat pads, the upper and lower limbs appear atrophic with pseudo-dissection of the adductor muscles, the buttocks are effaced, and subcutaneous veins are unusually conspicuous. Lipohypertrophy is characterized by central accumulation of fat with buffalo hump (6), breast enlargement and visceral fat accumulation (4). Three clinical types can be described:

Differences of abdominal adipose tissue distribution between males and females (fig. 7)

For control subjects, females have more subcutaneous adipose tissues than males (SAT: 149.05 cm² versus SAT: 122.7 cm²) and significantly less visceral adipose tissues than males (VAT: 69.8 cm² versus VAT: 109.36 cm²; p<0.05). The VAT/TAT ratio was significantly higher for males (VAT/TAT: 0.48±0.1 versus VAT/TAT: 0.32±0.09; p<0.05). Similar results were observed for patients. (SAT: 164.28 cm² in females versus SAT: 89.85 cm² in males; p<0.05); (VAT: 106.61 cm² in females versus VAT: 137.97 cm² in males; p<0.05). The VAT/TAT ratio was significantly higher for males (VAT/TAT: 0.62±0.15 in males versus VAT/TAT: 0.38±0.13 in females).
pure lipoatrophic, pure lipohypertrophic and mixed, the latter being more frequent.

The techniques to evaluate lipodystrophy associated abdominal adipose tissue redistribution are not very accurate (23). Anthropometric measurements including BMI, waist-hip ratio and skinfold thickness measurements are simple, rapid and inexpensive. However, inter-observer reproducibility is poor, and operator-dependent and require standardized measurement sites (25). In addition, measurement variability is great for obese and cachectic patients with abnormal values. These measurements remain approximate and cannot assess subcutaneous and visceral adipose tissue distribution (25). Bioelectric impedanceometry is inexpensive and reproducible but does not allow evaluation of regional fat distribution (2). Dual-energy X-ray absorptiometry (DEXA) allows evaluation of regional fat deposition on 2D images but cannot separate subcutaneous from visceral fat (26). Nonetheless, absorptiometry is valuable for upper and lower limb assessment even though it cannot separate subcutaneous from intra-muscular fat (27).

In the absence of a strict or easily usable definition (28), and the availability of multiple poorly reliable evaluation techniques and several hypotheses with regards to adipose tissue redistribution, one readily understands the difficulties in the assessment and grading of HIV associated lipodystrophy. Yet, this determination is essential to establish prognosis (especially the cardiovascular risk) and follow-up patients or treatment response over time.

CT and MRI can both be very helpful since they allow the evaluation of abdominal, both subcutaneous and visceral, adipose tissue distribution (4, 29).

Our technique was based on MRI evaluation of abdominal fat in lipodystrophic patients, a technique that Ross et al. described as the technique of choice (30, 31).

Our protocol included a single axial image of the abdomen at the L4 vertebral level. In a study, Thomas had acquired

Fig. 2:  Example of fat redistribution in a male patient with pure lipoatrophy (a) compared to a matched control subject (b).

- a 44 year old male with BMI of 22.1. Facial, limb and buttock fat wasting without abdominal obesity.
- b 44 year old matched control subject with BMI of 22.5.

Marked reduction of subcutaneous fat (SAT: 35 cm²) in the patient compared to the control subject (SAT: 97 cm²) without significant variation of VAT (VAT: 97 cm² versus 118 cm²).

Fig. 3:  Example of fat redistribution in a male patient with pure lipohypertrophy (a) compared to a matched control subject (b).

- a 38 year old male with BMI of 34. Abdominal obesity with waist-hip ratio <0.90 without peripheral lipodystrophy.
- b 36 year old matched control subject with BMI of 34.4.

Marked increase of visceral fat (VAT: 353 cm²) in the patient compared to the control subject (VAT: 248 cm²) without significant variation of SAT (SAT: 248 cm² versus 294 cm²).
**Fig. 4:** Example of fat redistribution in a male patient with mixed lipodystrophy (a) compared to a matched control subject (b).

- **a** 32 year old male with BMI of 20.8. Abdominal obesity with waist-hip ratio <0.90 with signs of peripheral lipoatrophy at the face, limb and buttocks.
- **b** 32 year old matched control subject with BMI of 21.8. Marked increase of visceral fat (VAT: 225 cm²) in the patient compared to the control subject (VAT: 58 cm²) with marked reduction of SAT (SAT: 47 cm² versus 78 cm²).

**Fig. 5:** Example of fat redistribution in a female patient with pure lipohypertrophy (a) compared to a matched control subject (b).

- **a** 40 year old female with BMI of 26. Abdominal obesity with waist-hip ratio <0.85 without peripheral lipoatrophy.
- **b** 41 year old matched control subject with BMI of 26.8. Marked increase of visceral fat (VAT: 125 cm²) in the patient compared to the control subject (VAT: 71 cm²) without significant variation of SAT (SAT: 195 cm² versus 190 cm²).

**Fig. 6:** Example of fat redistribution in a female patient with mixed lipodystrophy (a) compared to a matched control subject (b).

- **a** 41 year old female with BMI of 22.8. Abdominal obesity with waist-hip ratio <0.85 with signs of peripheral lipoatrophy at the face, limb and buttocks.
- **b** 41 year old obese matched control subject with BMI of 23. Marked increase of visceral fat (VAT: 244 cm²) in the patient compared to the control subject (VAT: 60 cm²) without reduction of SAT (SAT: 130 cm² versus 125 cm²).
volumetric data through the trunk which, in addition to requiring much post-processing time, was unnecessary since Ross et al. stated that a single axial image at the L4 vertebral level provided a representation of the entire abdominal fat (32). In our study, the examination was fast with an acquisition time of 22 seconds. Newer MR units can perform even faster acquisitions. Our measurements were precise with excellent inter-observer and intra-observer reproducibility and excellent intra-patient reproducibility from separate acquisitions. Percentages of measurement variation were low (<3% for inter-observer and <1% for intra-observer variation, with standard deviation between different acquisitions of <1.5 cm²). Gauthier et al. in an evaluation of abdominal fat using MRI also reported inter-observer and intra-observer variations in the range of 2% (33).

A standard T1W sequence provided excellent contrast between fat and other tissues. Regions of interest were manually placed over fatty tissues and surface area measurements were automated. To set a common dynamic range for all images, Gauthier et al. have placed a 1.5-cm diameter reference tube filled to capacity with a solution of gadolinium on either side of the subjects during data acquisition. The reference tube served as an internal marker to determine the threshold of pixels corresponding to adipose tissue. Calculation of adipose tissue surface area was based on summation of pixels corresponding to the defined interval (33). Reproducibility of measurements was excellent with both techniques.

CT with acquisition of a single axial image through the L4 vertebral level also is a reliable and reproducible method of measuring fat or muscle surface areas at the abdominal level (4, 34-36). Fat surface areas are measured by summation of all pixels with values between –150 and –50 HU (4). Correlation between CT and MRI measurements is excellent, as reported by Ohsuzu et al. (37). MRI is advantageous because it does not irradiate patients, which may be significant in HIV infected patients that may require repeated examinations.

In order to characterize the patterns of abdominal adipose tissue redistribution in patients with HIV associated lipodystrophy, we have compared patients to control subjects. MRI is the only reproducible imaging technique capable of providing this comparison since it would be unethical to expose control subjects to unnecessary ionizing radiation from CT. Previous studies using CT are different from our protocol since only HIV patients were included with no comparison to control subjects. Also, these studies were not dedicated to the evaluation of patients with lipodystrophy and were mainly looking at patterns of fat distribution in relation to treatments or biological processes (3, 38).

Also, patients should be compared to matched control subjects. We have matched each patient with a control subject according to race, age, sex and body mass index to minimize the impact of physiologic factors: Miller et al. have demonstrated that weight gain was associated with accumulation of visceral fat and lypohypertrophic state (8). Engelson et al. have evaluated the distribution of fat on MRI in HIV patients and suggested that age and weight gain could play a role in the accumulation of visceral fat (29). Oette et al. reported that physiologic fat distribution in the general population varies based on gender, a fact that we have verified in our study with control subjects (39). Comparing patients with matched control subjects provides a better assessment of the severity of the lipodystrophy, especially the cardiovascular risk, by determining the degree of visceral fat accumulation compared to the subcutaneous fat. However, our study did not allow us to establish normal values of SAT and VAT for each category of patients based on sex, age and BMI to grade the severity of redistribution. Currently, this evaluation cannot be routinely performed because comparison with matched normal control subjects remains necessary. Additional research including a larger number of patients would be needed. Reference standards would then be available, similar to those used with DEXA in the evaluation of bone mineral density.

HIV infection is a chronic disease. This method of evaluation using matched control subjects is advantageous for follow-up of lipodystrophy over time independent of phenotype modifications related to age or weight changes. Such an assessment is necessary to determine the efficacy of treatment and establish management.

We have defined the adipose tissue redistribution pattern of HIV associated lipodystrophy compared to matched control subjects. Little data exists in the literature about this. Overall, all patients included, HIV associated lipodystrophy is characterized by a significant increase of VAT and a significant reduction of SAT compared to control subjects. Engelson et al. (29) reported similar results. However, our results show differences of fat redistribution between males and females. Clinically, no female patient in our study presented with pure lipoatrophy, whereas all presented abdominal obesity with waist-hip ratio <0.85.
confirmed these findings since elevated VAT and reduced SAT were noted in males whereas females with elevated VAT showed no corresponding SAT reduction. Furthermore, SAT values of patients were higher than SAT values of control patients, but this was not statistically significant.

The VAT/TAT ratio was not significantly different between patients and matched control subjects (VAT/TAT: 0.38±0.13 in versus VAT/TAT: 0.32±0.09 (p>0.05).

Characterization of different clinical types of lipodystrophy has shown that, in males, abdominal adipose tissue redistribution was consistent with clinical findings: when signs of peripheral lipatrophy were present, abdominal subcutaneous fat was reduced. On the other hand, when signs of peripheral lipatrophy with emaciated face, limbs and buttocks were present, abdominal subcutaneous fat was not involved. This difference in HIV associated lipodystrophy seems related to sex. Indeed, female control subjects and patients had more SAT than males. Several authors have also reported that the physiological distribution of adipose tissues in the general population and lipodystrophic patients varies with sex: females have less abdominal visceral fat than males and more subcutaneous fat (35, 39, 40).

Abdominal fat redistribution from HIV associated lipodystrophy shares similarities with those observed in diabetes associated lipodystrophy. CT and MRI evaluations performed in patients with diabetes associated lipodystrophy showed a significant increase of VAT compared to non-diabetic patients with similar BMI (33, 41, 42). Gray et al. (41) have also reported that females with diabetes associated lipodystrophy showed elevated VAT without reduction of SAT. These results show that abdominal CT and MRI are poor indicators for lipatrophy in females whereas these is a good correlation between SAT and the degree of lipatrophy in males. This suggests that abdominal measurements in females should be combined with limb subcutaneous fat measurements. This raises the question as to which method is best to obtain limb measurements.

Studies comparing anthropometric measurements such as skinfold thickness, dual-energy X-ray absorptiometry, CT and MRI should be undertaken. Comparison with matched control subjects would again be required.

Conclusion

MRI is a reproducible technique to measure the surface area of adipose tissues. Our protocol was able to show the pattern of adipose tissue distribution in lipodystrophic patients and to demonstrate differences between males and females.

Contrary to males, the pattern of abdominal fat distribution is not a reliable indicator of the degree of peripheral lipatrophy in females. Therefore, follow-up studies to assess treatment efficacy for lipodystrophy in females should include a dedicated evaluation of limbs, as well as comparison to matched controls.

Comparison with matched normal control subjects is necessary to characterize fat redistribution and grade its severity. Studies of larger populations should provide reference standards of surface area or even volume of visceral and subcutaneous abdominal fat based on race, age, sex, and BMI. This would allow routine MRI evaluation of lipodystrophy associated to HIV or other metabolic etiologies (43, 44).

References


RY Carlier et al.


