Factors influencing the occurrence of a T2-STIR hypersignal in the lumbosacral adipose tissue

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Abstract

Purpose: The purpose of our study is to determine whether there is a relation between overweight, age, sex, ‘‘hospitalised/outpatient’’ status and a non-inflammatory hypersignal of the subcutaneous lumbosacral adipose tissue in T2 Short-Tau Inversion-Recovery (T2-STIR) MR imaging sequences.

Patients and methods: One hundred and six lumbar MRI, including a T2-STIR and T1 Fluid Attenuated Inversion-Recovery (FLAIR) weighted sagittal sequences, were retrospectively taken from the picture archiving and communication system (PACS) of our hospital and then made anonymous and analysed. The presence or absence of a T2-STIR hypersignal within subcutaneous adipose tissue behind the paraspinal muscle aponeurosis was determined. In addition, the weight, thickness of the fat tissue, the administrative status of the patient, the age, sex, time of the examination and, when present, the height of this hypersignal were noted. A univariate and multivariate analysis by logistic regression was carried out in order to examine the relationship between the data gathered.

Results: In the examinations selected, 25.5% (n = 27) demonstrated a T2-STIR hypersignal in the subcutaneous tissue. We identified the weight (P < 0.023), thickness of the fat tissue (P < 0.001), the age of the patient (P < 0.017) and the ‘‘hospitalised’’ status (P < 0.009) as significant variables associated with this T2-STIR hypersignal. The mean height of the hypersignal was 109.5 mm. Five of the 27 patients had an injection of gadolinium chelate and no enhancement was found at this level.

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The MRI study of the lumbar spine has become a daily occurrence in a great many hospital centers. The main indications consist of the search for degenerative disc disease with or without nerve root impingement, spondylarthropathy, spondylodiscitis or the suspicion of secondary neoplasm, in particular. The T2-STIR sequence is most often used in certain indications, such as in inflammatory and infectious disease due to its sensitivity [1]. On a routine basis, we are often confronted with the presence of a T2-STIR hypersignal at the subcutaneous lumbar fat, that is discovered by chance (Fig. 1) and that, in rare cases may be mistaken for inflammatory or infectious infiltration. This T2 hypersignal accumulates along the superficial fascia, separating the subcutaneous fat tissue into a deep and a superficial layer. Few studies have described this anomaly by slice imaging [2,3] and only Shi et al. have demonstrated the correlation between overweight and its presence [2]. Our study aims at confirming these results and extending them by adding factors, such as the thickness of the fat and the status of the patient (hospitalised/outpatient) during the examination.

**Conclusion:** We found a significant link between overweight, age and “hospitalised” status and the non-inflammatory infiltration of lumbar adipose tissue. This phenomenon seems to correspond with an interstitial oedema, related to subcutaneous stasis. This anomaly should not be confused with a local inflammation.

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# Patients and methods

## Population

Our PACS was used to carry out a search from October 2011 to March 2012. Examinations noted as “lumbar spine MRI” comprising at least one T2-STIR sequence and a T1-weighted sequence in a sagittal plane centred on the entire sacrum and lumbar spine corresponded to the searched for criteria. OsiriX V3.2.1® software was used to extract and render 158 examinations anonymous. The reasons that examinations were carried out varied: lower back pain, radiculalgia, suspicion of spondylarthropathy, primary or secondary neoplasm, assessment of traumatic lesions and the suspicion of spondylodiscitis.

The criteria for exclusion were: a past history of lumbar surgery, secondary or primary locoregional neoplasm, recent traumatic lesions (less than 6 months and defined by the presence of a T2-STIR hypersignal due to the oedema), active spondylodiscitis, local infectious or inflammatory lesions (baastrup syndrome, myosytes, etc.) due to a probable correlation with an oedema of the subcutaneous fat tissue. Therefore, 39 examinations were excluded. For patients undergoing several MRI during this period, only the first examination was included in this study, thereby, excluding 13 examinations.

Finally, for all of the patients, we had to have their weight and their “hospitalised/outpatient” status at the time of the examination.

A total of 106 examinations were included in this study.

## Technical parameters

All of the examinations were carried out in a single centre university hospital on a 1.5T MRI (Signal Excite HD General Electric Healthcare, Milwaukee, USA). The parameters of the T2-STIR sequence were: TE = 68 msec, TR = 3650msec, TI = 150 msec, slice thickness: 4 mm, Fov: 48 cm.

All of them also have a T1-weighted sagittal FLAIR sequence (TE=9.1 msec, TR = 1951.4 msec, TI = 800 msec, slice thickness: 4 mm, Fov: 48 cm).

## Data analysis

The different MRI were analysed retrospectively by a junior radiologist. Data was gathered on the age, sex, weight, “hospitalised/outpatient” status and time of the examination. For each examination, we measured the maximum thickness of the posterior fat tissue on a T1-weighted sagittal section passing through the spinous process (Fig. 2). When a T2-STIR hypersignal was present behind the aponeurosis of the paraspinal muscles, we measured its maximum

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**Figure 1.** Median signal anomaly in the deep adipose plane opposite the spinous process. a: corresponds to a hypersignal on the sagittal T2-STIR sequence (white arrow); b: and a hyposignal on the T1-weighted sagittal sequence (black arrow).
Results

Our population was predominantly female, in particular, in subjects under the age of 50. Patients weighing less than 70 kg accounted for over 50% of our sample. The mean weight of our population was 69.89 kg (37 to 109 kg). Moreover, in subjects presenting a hypersignal ($n = 27$), the mean weight was $82.8 \pm 12.3$ kg vs $65.4 \pm 13.5$ kg in subjects without this hypersignal ($n = 79$) (Table 1).

A T2-STIR hypersignal of the subcutaneous tissue was found in 27 patients (25.5%) in our study. The mean of the epicentres of this T2-STIR hypersignal is found opposite disc L3–L4.

The correlation between the weight and the presence of this hypersignal was statistically proven by uni- and multivariate analysis ($P = 0.040$ with 95% CI [0.00249; 0.1075]). The same is true of the thickness of the fat, with a stronger correlation ($P = 0.001$ with 95% CI [$-21.9315$; $-6.0648$]). In addition, the “hospitalised” status also seems to be related to this hypersignal ($P = 0.011$ with 95% CI [0.3812; 2.9694]) as well as age ($P = 0.017$ with 95% CI [0.0064; 0.0666]). The other variables studied, such as sex and the time of the examination were not statistically correlated with this anomaly of lumbar subcutaneous fat tissue by univariate analysis.

The height of this hypersignal is significantly correlated with the weight of the patients in our population ($P = 0.048$ with 95% CI [0.0219; 4.1716]) but not the thickness of the fat ($P = 0.446$ with 95% CI [$-2.6506$; 1.2026]).

Of the 27 MRI presenting a lumbosacral hypersignal, 5 patients had an injection of gadolinium chelate (Dotarem 0.5 mmol/mL, gadoteric acid, Guerbet, 95943 Roissy CDG Cedex, France) and none of them presented enhancement of T1 sequences at this level.

The distribution of the hypersignal, studied on sagittal sections and on several axial planes (4 examinations in patients presenting a hypersignal with T2-STIR sequences in an axial plane), was on the posterior median line in the deep subcutaneous adipose tissue, close to the superficial fascia of the paraspinal muscle (Fig. 4). It extends laterally without reaching the superficial fat layers.
Table 1  Demographic distribution between the two groups: with and without the presence of the hypersignal in MR Imaging.

<table>
<thead>
<tr>
<th></th>
<th>“Hypersignal”</th>
<th>“Without hypersignal”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number</td>
<td>27 (25.47%)</td>
<td>79 (74.53%)</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min and max</td>
<td>Min: 60</td>
<td>Max: 106</td>
</tr>
<tr>
<td>Mean</td>
<td>82.81</td>
<td>65.46</td>
</tr>
<tr>
<td>Median</td>
<td>85</td>
<td>65</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>12.34</td>
<td>13.56</td>
</tr>
<tr>
<td>Distribution men/women</td>
<td>M: 7 (25.9%)</td>
<td>W: 20 (74.1%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M: 24 (30.4%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>W: 55 (69.6%)</td>
</tr>
<tr>
<td>Outpatient/hospitalised status</td>
<td>O: 13 (48.15%)</td>
<td>H: 14 (51.85%)</td>
</tr>
</tbody>
</table>

*: Percentage; W: women; M: men; O: outpatient; H: hospitalised.

Figure 4. Axial sections in T2-STIR (a) and T1 (b), showing the arrangement of the oedema not crossing the superficial fascia separating the deep from the superficial adipose tissue.

Discussion

The T2-STIR hypersignal of the adipose tissue opposite the fascia of the paraspinal muscles is often found in our series, although not as often as in the study by Shi et al. [2]. We also support the hypothesis of the oedematous but non-inflammatory nature of the anomaly considering the lack of enhancement after injection and confirm the significant link between the occurrence of this oedema, overweight as well as the age of patient. The epicentre of this oedema is similar to that in the study by Shi et al. [2], that is, opposite disc L3–L4. A link has also been established with the thickness of the adipose tissue that seems to be a better reflection of the local distribution of the adipose tissue than the gross weight. The height of this hypersignal, reflecting the severity and extent of the oedema, is correlated with the weight of the patient but not with the thickness of the adipose tissue. The correlation found with the administrative status of the patient seems to be attributed to more prolonged bed rest in hospitalised patients. Bed rest seems to contribute to the sloping distribution of the oedema but also plays a role in its formation by reduction of the lymphatic and venous return with stasis. Age also seems to be a factor influencing the occurrence of this oedema, probably related to the modifications in the structure of the fat tissue, in particular by its disorganisation, making the fat layers slacker and by its loss of elasticity with age probably accounting for this correlation. They are also more subject to venous insufficiency and lymphatic return disorders.

Physiologically, the extracellular oedema is usually created either by a leak of fluid from plasma by an increase in capillary filtration towards the interstitial spaces or by default in the lymphatic return. Several hypotheses have been formulated in obese patients. On the one hand, the increase in abdominal pressure leads to an increase in the venous pressure and capillaries, thereby, increasing the filtration towards the interstitial fluid and also reducing the lymphatic return. Other factors, such as microcirculation disorders or hormonal disorders (such as the increase in the secretion of aldosterone or antidiuretic hormone) contribute to it. On the other hand, a dysfunction of the autonomous system (parasympathetic and sympathetic) seems to play a role. In fact, in obese patients, there is a decrease in cutaneous vasoconstriction in response to the sympathetic activation, thereby, increasing the blood volume of the capillaries as well as their permeability [4,5].

As opposed to the results published by Shi et al. [2], we did not find a correlation with sex. In fact, the non-equal distribution of fat tissue between the sexes may have had an effect on the occurrence of the oedema. In addition, a correlation was not found between this oedema and the time of the examination. The latter data seems to be biased since the time of the examination is not representative in the hospitalised patients due to prolonged bed rest.
The distribution of this oedema seems to be accounted for anatomically and histologically [4,5]. A membrane, called superficial fascia, separates the deep fat layers from the superficial fat layers. It is present on the entire circumference of the trunk [6—10], clearly visible in the CT scan (Fig. 5). It clings to the superficial fascia of the posterolateral lumbar paraspinal muscles and detaches in the sacral region [11]. The distribution of the adipose tissue, thereby separated in two, varies according to different parameters, such as weight, sex, hormonal status, etc. These two fat layers differ structurally. The superficial layer presents lobes of polygonal, oval fat cells as opposed to the deep layer presenting oblique fibrous partitions defining lobes of large and flat fat cells. This deep layer is globally less structured and less compact. This may account for the accumulation of the oedema at this level [12].

Functionally, the membranous superficial fascia may play a role in the integrity of the skin and the support to the subcutaneous structures, especially for the veins, by ensuring their permeability. An understanding of the topography of this aponeurotic layer may help account for deformations of the body contour and provide the anatomic basis for surgical correction [13,14].

Moreover, Lakadamyali et al. have clearly shown that this hypersignal is often discovered by chance and that it is not associated with lower back pain (common reasons for the consultation) [15,16]. This oedema may be part of the different traps described in the analysis of spinal MRI [17].

The results of our retrospective study may be qualified due to certain limits, in particular, the small size of our population and a non-homogenous group. In addition, no clinical examinations were carried out to assess the lumbosacral oedema. The past history of the patients, in particular, concerning venous insufficiency or systemic diseases, as well as the administration of anti-inflammatories was not available. In addition, it was not possible to confirm the lack of a picture of anaasarca, in spite of the lack of effusion visualised in the retro-uterine pouch, visible in the different sequences obtained. In the hypothesis that, part of the occurrence, but especially the arrangement of this oedema may be mechanically accounted for by the sloping, an examination in prolonged procubitus could have been carried out in order to determine whether or not there was a reduction and/or redistribution of the oedema. Our retrospective study did not allow us to confirm this hypothesis.

Conclusion

An oedema of the lumbar subcutaneous fat tissue is often found, in particular in the overweight, elderly and bedridden. However, before attributing this oedema to physiological phenomena, it is necessary to make sure that there are no local underlying disorders, such as myositis, recent surgery, interspinous infectious diseases, etc.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

References


