The frequency of high signal intensity on T2-weighted MRI at the iliacus muscle enthesis of the iliac fossa: evidence of enthesopathy?

Poster No.: C-1438  
Congress: ECR 2013  
Type: Scientific Exhibit  
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Keywords: Musculoskeletal soft tissue, MR, Diagnostic procedure, Normal variants, Trauma, Arthritides, Athletic injuries  
DOI: 10.1594/ecr2013/C-1438

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Purpose

Enthesopathy refers to a variety of disorders including inflammation, degeneration and micro-damage of tendon and ligament insertions. Although commonly associated with pathology at the Achillies tenon insertion, inflammatory changes have been reported at many enthesis organs (1). Histopathological samples show evidence of microtrauma, inflammation and enthesophyte formation (2).

Magnetic resonance (MR) imaging of enthesopathy shows swelling of entheses, and diffuse areas of high signal intensity (HSI) around adjacent bone and soft tissue (3). Inflammatory changes are not only found focally around the insertion, but may also occur some distance away in both spondylarthropathies and overuse injury such as lateral epicondylitis (4). Such changes can be seen as HSI on fat suppressed MR imaging; T1-weighted imaging cannot clearly show inflammation of tendons and ligaments, but may be of use in examining bone marrow changes (5) or increased fibrocartilage mass.

The frequency of enthesopathy is unknown. A recent study by Gutierrez et al (6) detected asymptomatic enthesopathy in between 8.4% of their healthy population; many other studies investigate enthesopathy in the context of psoriatic and spondylarthropathies, finding variable incidences, as high as 57% (7). Presence of enthesopathy may indicate future development of spondylopathies (8), and reliable information on its prevalence is important for both diagnosis and early treatment.

The subclinical finding of HSI at the iliacus enthesis at the iliac fossa on MR imaging was investigated to gain a greater understanding of this enthesis organ and its role in pathology.
Methods and Materials

Patients

554 pelvis and hip joint MR examinations acquired over one year (July 2011 - July 2012 at the Jikei University Hospital) were retrospectively reviewed by a medical student (JL), supervised by a radiologist (KF) with twenty years of experience in musculoskeletal imaging, blinded to patient demographic and clinical information.

Ages ranged from 5-94y (mean 52y). 364 cases were female; 190 were male. Repeat examinations, images where the iliacus muscle was not visible, and patients with inflammatory sacroilitis or radiotherapy in the pelvic regions, and bone metastasis or insufficiency fractures at the iliacus enthesis organ were excluded.

Imaging protocol

The iliac muscle was evaluated on a T1-weighted image, and at least one of a T2-weighted imaging, short tau inversion recovery (STIR) image or low-b-value diffusion weighted (DW) image, using a 1.5T scanner (MAGNETOM Avanto, Siemens Healthcare) and body coil.

Coronal and axial images were available for all patients included in the study, maximizing the MR coverage of entheseal regions. A typically a spin-echo sequence was employed for T1-weighted (TR/TE, 500/10ms, FOV, 256x256, FA, 150°) and T2-weighted (TR/TE, 3000/100ms, FOV, 256x256, FA, 180°) images. A spin-echo inversion recovery sequence was employed for STIR images (TR/TE, 2000-5000ms/30-50ms, T1, 180ms, FOV, 256x256, FA, 130-180°) and a spin-echo echo-planar image for DW images (TR/TE, 2700/76ms, FOV, 256x256, FA, 90°).

Interpretation

Focal and/or diffuse areas of abnormal HSI on STIR, T2-weighted or DW sequences were recorded by JL and KF in consensus as possible enthesopathy. Patient demographic information, clinical information and presence of previous examinations on record was recorded; any previous examinations were reviewed when HSI was observed.
Statistical analysis was performed in SPSS 17.0. Independent t-tests with significance level \( p<0.05 \) were used to assess differences and abnormalities of statistical significance.
Results

HSI was present on 131 examinations (23.6%; 95CI: 20.1-27.1%). Example images are shown in figures 1-3.

Mean age for those with positive findings was 68.6 years (95CI: 55.5-70.7y), compared with 46.8 years (95CI: 45.1-48.5y) for those with negative findings (p<0.0001). The proportion of patients affected in different age groups is shown in figure 4.

No significant difference in incidence was found between male and female patients (23.2% and 23.9% of patients respectively). Male patients in whom HSI was observed were younger on average: 66 years (95CI: 62.8-69.2y) in the male group compared with 70 years (95%CI: 67.4-72.7y) for females (p=0.158).

HSI was bilateral in 51.1% of cases (95CI: 42.5-59.7%); patients with bilateral findings were older relative to those with one-sided findings (72.8 and 62.5 years respectively, p=0.0002).

HSI was found either on the same side as pathology or bilaterally in 80% of HSI-positive cases (95CI: 71.6-88.5%).

In patients where abnormal HSI was found, 24 (18.3%) had additional old examinations available to review. Negative findings on previous investigations were observed in 7 cases (5.3%); an example is shown in fig. 3. The time between negative and positive scans ranged from 0.33-4.25 years (figure 5).
Fig. 1: Fig. 1-82-year-old female with sigmoid colon cancer and bilateral sacroiliac insufficiency fractures. MR imaging shows bilateral HSI at the iliacus insertion into the iliac fossa (arrows) on (a) coronal STIR image, (b) axial STIR image, (c) axial low-b-value DW image and (d) axial ADC map.

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Fig. 2: Fig. 2-94-year-old female with left-sided hip pain; no pathological abnormality was found on MR imaging. HSI is present bilaterally at the iliacus insertion (a, b), and also at the psoas major attachment to the spine (c, d). Coronal STIR and corresponding T2 weighted images are shown in a/c and b/d respectively.

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Fig. 3: 67-year-old female with breast cancer and metastasis to bone. (a) coronal STIR image acquired in 2007 showing no evidence of enthesopathy. (b) coronal STIR image acquired in 2011 showing right-sided enthesopathy at the iliacus insertion.

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Fig. 4: Percentage (with 95% confidence intervals) of patients in different age groups with positive findings on MRI.

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Fig. 5: Fig. 5 - Seven patients with positive findings on the most recent investigation had previous examinations negative for enthesopathy on record. This table shows the time period within which enthesopathy may have developed.

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Conclusion

Inflammation, degeneration and micro-damage of enthesis organs is known to be a common finding in elderly patients at areas of frequent use. For example, signs of degeneration around the temporomandibular joint are almost universal in old age (2). This study investigated abnormal HSI around the iliacus enthesis: abnormal intensity was found in a much larger proportion of the population than current literature suggests.

In the population studied most examinations were pathological, meaning many of these cases may be non-enthesitis-related HSI. Several cases with positive findings had confirmed causes, e.g., the youngest patient in this group was a 33-year-old with sacroiliitis. In the elderly population other pathologies such as avulsion injuries may be responsible. Further anatomical study of cadaveric specimens is necessary to confirm the presence of enthesopathy.

Enthesopathy and age

Abnormal signal intensity around the iliacus insertion was predominantly found in older patients. Even when other causes such as avulsion injuries are into account, the number of elderly patients with HSI was still unexpectedly high. Few positive cases were seen in patients under 60 years old, compared with 93% of those over 80 (fig. 4). This supports the proposed mechanism of recurring stress: older patients have been exposed to the forces generated through locomotion for longer, and may be more likely to develop enthesopathy.

Some evidence of progression was found. Fig. 5 shows seven patients who were negative on their first investigation, but showed evidence of enthesopathy on later images. Fig. 3 shows MRI images from one such patient. Furthermore, a greater proportion of findings in elderly patients were bilateral; possibly due to longer exposure to mechanical stress increasing the likelihood both sides will become affected.

Recurring stress as a causative factor

A greater number of patients had bilateral than right or left-sided HSI. This again supports the theory that enthesopathy is predominantly caused by recurring stress; if trauma was the primary pathogenesis right or left-sided could be expected to be more common. Evidence was also found of inflammatory changes in the spine (fig. 2), consistent with previous work finding enthesitis in areas away from the enthesis (4). Right-sided findings
were more common than left sided, perhaps because the right is the dominant foot for a greater proportion of the population, exposing it to higher forces.

Bilateral findings occurred in males at a younger age than females (p=0.0208). This is perhaps due to higher forces generated at the enthesis due to stronger muscles or more frequent use. Males are also more likely to be overweight in this population, which may also factor into the mechanical stress imposed. The most likely cause however is that because the proportion of females in the >80-years-old group is 86%, the difference in mean age appears artificially significant: the finding is only weakly significant and is not found in either left or right sided HSI; further investigation is necessary to confirm this finding.

**Enthesopathy and pathology**

Enthesopathy may be associated with pathology. Often a subclinical finding, enthesopathy has been proposed as a mechanism for pain and immobility (9). This may explain why the prevalence in this work, which included mostly pathological examinations, was so different compared with previous literature. A recent study by Taniguchi et al (9) employed 18F FDG-PET/CT to investigate polyenthesitis in a healthy Japanese population, finding asymptomatic enthesitis in only 0.7% of 1000 subjects.

The proportion of studies where HSI was found on the same side as pathology further evidences this association: 65% if patients with bilateral HSI occurring with either left- or right-sided pathology are excluded, and 80% if such patients are included. Pathological processes may lead to weakness and subsequent enthesopathy; alternatively age-related degeneration may cause enthesopathy, predisposing to pathology. Further work is needed to fully investigate this.

**Limitations**

The cases included in this study were biased towards gynecological and hip fracture investigations; this inevitably led to a disproportionate number of female examinations. This was particularly evident in the over 80-year-old age group, where 93% of examinations showed HSI, apparently increasing the average age of female patients with HSI.

Many patients examined had received chemo- or radiotherapy. The effect of these treatments on enthesis organs is unknown, but if fibrocartilage is deposited in entheses around areas of recurring stress, tissues may be rapidly dividing and affected by cytotoxic treatments, perhaps exacerbating enthesis.
No information was available on co-morbidities and lifestyle factors. Exercise, BMI and previous fractures may all have been useful in determining the cause of enthesitis in elderly patients, particularly as metabolic disease is known to be associated with enthesopathies (10).

Finally the study was retrospective, making it difficult to determine if enthesopathy affects pathology or pathology affects enthesopathy.

**Conclusion**

Enthesopathy around the iliacus enthesis is a common finding in elderly patients. This study suggests weakness and recurring mechanical stress lead to the inflammatory changes observed, which show a strong association with pathology. Enthesopathy in this area may be an overlooked cause of groin pain and weakness.
**Fig. 1:** 82-year-old female with sigmoid colon cancer and bilateral sacroiliac insufficiency fractures. MR imaging shows bilateral HSI at the iliacus insertion into the iliac fossa (arrows) on (a) coronal STIR image, (b) axial STIR image, (c) axial low-b-value DW image and (d) axial ADC map.

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