Concise Report

Mural inflammatory hyperenhancement in MRI of giant cell (temporal) arteritis resolves under corticosteroid treatment

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Objective. To determine the effect of corticosteroid treatment on mural inflammatory hyperenhancement in MRI in GCA.

Methods. MRI of the superficial temporal artery with sub-millimetre in-plane spatial resolution (195 × 260 μm) was performed in 17 patients with proven GCA at the initiation of corticosteroid treatment and after 16 months of therapy. Visual MRI scores for mural inflammation were correlated with clinical and laboratory findings.

Results. Intensity of inflammatory hyperenhancement decreased significantly under corticosteroid therapy (2.3 ± 0.6 vs 0.5 ± 0.6, P < 0.001, with MRI score >2 indicating vasculitis). This finding correlated with the clinical and serological remission in 15/17 patients. Of the two patients with active disease, one had persisting mural inflammation in MRI indicative of relapsing disease. The other patient presenting with signs of polymyalgia rheumatica had no inflammatory changes of the superficial temporal arteries on MRI scan at follow-up.

Conclusions. Mural contrast enhancement in high-resolution MRI is pronounced in active disease and decreases under corticosteroid treatment, correlating well with laboratory remission.

KEY WORDS: Giant cell arteritis, Steroids, MRI, Vasculitis.

Introduction

GCA usually involves the superficial cranial arteries with predominance of the temporal arteries. As a result, clinical symptoms include (temporal) headaches, localized scalp tenderness and jaw claudications. Classification is based on the criteria defined by the ACR [1] containing temporal artery biopsy (TAB) as the recognized diagnostic gold standard. Colour-coded duplex ultrasonography is a non-invasive imaging modality of high clinical value if performed by experienced ultrasonographers [2]. However, its clinical value has been debated and its sensitivity and specificity vary considerably with varying pre-test probabilities of GCA [3, 4]. A non-invasive, high-resolution MRI protocol for assessment of mural inflammatory hyperenhancement in GCA has been introduced elsewhere [5]. The technique allows for high detail visualization of active mural inflammatory changes of the superficial cranial arteries such as increased contrast enhancement, wall thickening and luminal narrowing. After confirmed diagnosis, the treatment of choice is high-dose corticosteroid medication that is slowly tapered over the course of several months monitoring serological and clinical parameters for signs of relapse [6]. During the withdrawal of steroids, patients may present with non-specific headaches and increase of inflammatory parameters caused by reasons unrelated to GCA, e.g. intercurrent infections. To the best of our knowledge, no additional parameter has yet demonstrated a high specificity to differentiate relapse of the vasculitis from other unrelated causes. A non-invasive imaging tool for assessment of disease activity would be favourable. MRI has been proven to depict active disease in the superficial cranial arteries [7–10]. The purpose of this study was to evaluate MRI findings under corticosteroid treatment in a series of patients with proven GCA and how they correlate with clinical and laboratory inflammatory markers.

Methods

Study population

Among 21 consecutive patients who presented at the University of Freiburg with clinical suspicion of GCA, and who were referred to MRI for evaluation of the superficial cranial arteries, 17 patients (10 female, 7 male, mean age 68 yrs) were diagnosed as having GCA (based on ACR criteria and TAB when applicable). These 17 patients had received corticosteroid treatment for a mean of 16 months, when they were prospectively scheduled for a follow-up examination including a second MRI, clinical evaluation by an experienced rheumatologist and laboratory testing of ESR and CRP. Written informed consent was obtained from each patient prior to the MRI investigation. The study was approved by the local ethics review committee at our institution and complied with the Declaration of Helsinki.

MRI examination

High-resolution MRI was performed on a 3 tesla scanner (Trio, Siemens Medical Solutions, Erlangen, Germany). A commercially available eight-element phased-array head-coil was used. A previously reported MRI protocol was used consisting of post-contrast, fat-saturated, multi-slice T1-weighted spin echo (SE) imaging with sub-millimetre spatial resolution of 195 × 260 μm [11]. Thirty axial oblique slices (slice thickness = 3 mm) were used to cover all superficial cranial arteries within a total scan time of <15 min. The acquisition of SE images was initiated ~1 min after venous injection of 0.1 mmol/kg of a gadolinium-based contrast agent (multihance®, Bracco/Altana, Konstanz, Germany).

MRI evaluation

Images were evaluated in a consensus reading by two expert radiologists who were blinded to clinical data and to the sequence...
of investigations. For MRI diagnosis, mural thickening (>600 μm) and/or presence of mural hyperenhancement were considered as signs of mural inflammation according to a previously published 4-point ranking scale with 0 = no mural thickening (<0.5 mm) and no mural enhancement, 1 = no mural thickening (<0.5 mm) with only slight contrast enhancement, 2 = mural thickening (>0.6 mm) and prominent mural enhancement, and 3 = strong mural thickening (>0.7 mm) and strong mural enhancement (Fig. 1). Scores of 0 and 1 were rated as physiologically normal, whereas 2 and 3 were considered as signs of mural inflammation [5]. MRI evaluation was performed electronically on enlarged images using state-of-the-art radiology work stations (J-Vision, Tiani, Austria).

**Clinical follow-up**

All patients were examined by a rheumatologist experienced in diagnosis and treatment of patients with GCA. While the initial steroid dosage was 1 mg prednisolone equivalent/day/kg body weight, the treatment was tapered according to the clinical and serological responses. CRP and ESR were tested. Physical examination and laboratory tests were performed on the same day of the follow-up appointment prior to MRI.

**Statistical analysis**

The mean values and s.d. for CRP, ESR and the MRI evaluation score were calculated for the patients at initial presentation and at the follow-up investigation. The Wilcoxon signed-rank test was used to compare the initial findings (MRI, ESR and CRP) with the follow-up investigation.

**Results**

In all patients, high-resolution MRI of the superficial cranial arteries was successfully performed. The left and right superficial temporal as well as superficial occipital arteries were depicted in all patients, allowing for a radiological assessment of vasculitic signs. No adverse effects related to contrast agents or other MR limitations such as claustrophobia were encountered. Clinical evaluation of active disease, values of ESR and CRP, and results of TAB and MRI scores at initial presentation and at the follow-up examination of the individual 17 patients are given in Table 1. Decrease of mean CRP, ESR and MRI score from initial presentation to follow-up investigation was statistically significant with P-values <0.001, according to the Wilcoxon signed-rank test.

Clinical remission was achieved in all but two patients (Patients 3 and 8). However, in 8/17 patients, CRP and ESR were still elevated with mean CRP of 9.44 mg/dl and mean ESR of 19.5 cm in the first hour. MRI inflammatory signs vanished in all patients who were in clinical remission. One of the clinically active patients (Patient 3) had a positive MRI at follow-up and presented with recurrent pain in the shoulders and neck under 5 mg/day of steroids, CRP of 10.2 mg/l and ESR of 15 mm in the first hour. The other patient under steroid treatment with signs of active disease (Patient 8) reported new onset of myalgias of the shoulders and thighs and had a negative follow-up MRI. He denied any headaches. ESR was elevated to 77 mm in the first hour and CRP was 39.8 mg/l. These findings were evaluated as signs of polymyalgia rheumatica [12]. Overall, a highly significant association of negative MRI and clinical and serological remission was observed with $k = 0.638 \pm 0.226$ and 95% confidence interval of $0.195-1.081$ ($P=0.005$).

**Discussion**

GCA usually responds well to steroid treatment [13]. Clinical symptoms as well as laboratory parameters often normalize within

a short time after initiation of therapy [14]. However, during the reduction of steroids, up to 70% of patients may show new onset of symptoms compatible with relapse of vasculitis [14]. Sometimes, it is difficult to differentiate recurrence of disease from unrelated conditions solely by assessment of patient’s complaints, physical examination and laboratory testing. A non-invasive imaging approach for documentation of relapsing disease would therefore be desirable. This requires a normalization of the initially pathological signal. In this study, we were able to demonstrate that the inflammatory changes seen in MRI vanish under successful steroid treatment. High-detail visualization of the superficial cranial arteries was feasible with the use of non-invasive MRI in all patients for both initial and follow-up examinations. After 10–22 months of corticosteroid treatment, MRI inflammatory signs were undetectable in all but one patient. Similarly, treatment led to decreased enhancement in large-vessel vasculitis, possibly indicating improving disease status [15, 16]. Importantly, all patients with clinical remission presented with normal MRI findings. The only patient with inflammatory changes in MRI was diagnosed as having a relapse of disease by clinical means and laboratory evaluation. Only 1/17 patients had discordant results in clinical and radiological judgement, demonstrating an excellent correlation of the MRI results with the clinical and serological evaluations. In this particular patient, polymyalgia rheumatica was suspected as the patient denied headaches and reported new onset of myalgias of the shoulders and calves.

The characteristic halo in colour-coded duplex ultrasonography has been reported to vanish within a mean of 16 days of corticosteroid treatment (min. 7, max. 50 days) under steroid treatment [2]. This correlates well with PET findings: Turlakow et al. [17] reported normalization of the PET scan 2 weeks following treatment with prednisolone. Also, TAB can be positive for up to 2 weeks following the initiation of steroid therapy [18]. It is not known how long MRI changes persisted after initiation of steroid treatment. In a previous trial of 64 patients, sensitivity of high-resolution MRI amounted to 85.5% in 50 patients who were investigated within 10 days after starting corticosteroid treatment as compared with 80.6% in the 14 patients who received corticosteroids for more than 10 days [19]. This finding already indicates that mural hyperenhancement may undergo considerable changes within the first 2 weeks under corticosteroid treatment. This emphasizes that for initial diagnosis, MRI should be performed before or early in the course of corticosteroid treatment to avoid false-negative MRI results.

In conclusion, this study shows that mural inflammatory hyperenhancement in MRI of the cranial arteries vanishes with decreasing inflammatory activity under long-term corticosteroid treatment. MRI results correlate well with laboratory remission. It needs to be confirmed whether relapsing disease will reliably be detected by MRI in a larger cohort of patients.

### References

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