MRI of the plantar plate in the painful forefoot of patients with rheumatoid arthritis

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Introduction: Cadaveric studies of rheumatoid arthritis (RA) have suggested that the forefoot pain and deformity commonly reported in RA might result from failure of the complex ligamentous system and displacement of the plantar plates[1]. The plantar plates are fibrocartilaginous structures which have an important role in maintaining the structural integrity of the MTP joints. Damage to the plantar plates is a potential mechanism through which the characteristic painful forefoot deformity may develop in patients with RA. However, the relationship to other features of RA (synovitis, bone marrow oedema and bone erosion) is unknown. MRI has been used to identify the plantar plate (Figure 1a) and visualise tears in subjects without arthritis[2] and is also widely used for assessing other joint pathology. The aim of this study was to use MRI to investigate plantar plate pathology in painful lesser (2^{nd}-5^{th}) MTP joints in patients with RA and to determine whether plantar plate pathology is associated with other changes of RA.

Methods: In 24 patients (17 females: 7 males; mean age 55.5 years) with RA, the more symptomatic forefoot was imaged at 3T using an eight-channel rf coil. PD weighted FS (TR3500, TE35, 0.5x0.3 mm in-plane resolution, 3mm slices) and T2 weighted FS images (TR4100, TE92, 0.5x0.3 mm in-plane resolution, 3mm slices) were acquired in the sagittal and axial planes through 96 lesser MTP joints. Sagittal and coronal T1 weighted FS (TR800, TE16 0.5x0.3 mm in-plane resolution, 3mm slices) and 3D VIBE (TR9, TE5, flip-angle=30º 0.7x0.6x0.8mm resolution) images were acquired after administration of 0.1 mmol/kg intravenous contrast agent. Plantar plate pathology (PPP) was defined as absence of the plantar plate, or a full width (Figure 1b) or partial width tear, including failure to visualise the medial or lateral distal insertions. Images were scored for synovitis, bone oedema and bone erosion at each lesser MTP joint using the rheumatoid arthritis MRI score (RAMRIS)[3]. MR images were read by two experienced musculoskeletal radiologists and consensus reached. Two-tailed Mann-Whitney U tests were used to test for a difference in RAMRIS scores between those lesser MTP joints with plantar plate pathology and those without. The level of significance was set at $P<0.05$.

Results: One or more lesser plantar plates was absent in 9 (38%) patients. All the lesser plantar plates were absent in one patient. Pathology in one or more lesser plantar plate was identified in 14 (58%) patients. In total, 16/96 (17%) plantar plates were absent and pathology was observed in 22 (28%) of the 80 remaining plantar plates. All pathology was located distally in the plantar plates. The 5th MTP joint was the most common site for all types of pathology.

The relationships between plantar plate pathology and other imaging features of RA at each lesser MTP joint are given in Table 1.

Table 1 – Comparison of plantar plate pathology (PPP) with RAMRIS scores of synovitis, bone oedema and bone erosion.

RAMRIS		MTP 2		MTP 3		MTP 4		MTP 5	
		PPP Present	PPP Absent	PPP Present	PPP Absent	PPP Present	PPP Absent	PPP Present	PPP Absent
Synovitis	Median	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
	p-value	NS		NS		NS		NS	
Bone Oedema Proximal	Median	1.5	0.0	1.5	0.0	2.0	0.0	2.0	1.0
	p-value	**0.014**		**0.027**		**0.040**		**0.026**	
Bone Oedema Distal	Median	1.0	0.0	1.0	0.5	1.0	0.0	1.0	0.0
	p-value	NS		NS		NS		**0.028**	
Bone Erosion Proximal	Median	3.0	1.0	3.5	1.0	1.0	0.0	2.0	0.0
	p-value	**0.008**		**0.003**		**0.020**		**0.007**	
Bone Erosion Distal	Median	1.0	0.0	1.5	0.0	1.0	0.0	1.0	0.0
	p-value	**0.031**		**0.007**		**0.028**		**0.028**	

There was significantly more bone oedema and bone erosion in lesser MTP joints with plantar plate pathology. No such relationship was found between synovitis and plantar plate pathology.

Discussion: The study has demonstrated that plantar plate pathology is associated with bone oedema and bone erosion at the lesser MTP joints in patients with RA. This may be due to i) bone damage as a result of abnormal biomechanics following plantar plate destabilisation, ii) damage to the plantar plate by an eroded, irregular metatarsal head or iii) a common cause for both bone and plantar plate pathology. Longitudinal studies will be necessary to elucidate causality. No such association was seen with synovitis. Plantar plate pathology appears common in patients with forefoot plantar pain and RA (79.2% of patients) and given the importance of the plantar plate to foot stability, this raises the possibility that plantar plate pathology may contribute to symptoms and deformity at the lesser MTP joints[1].

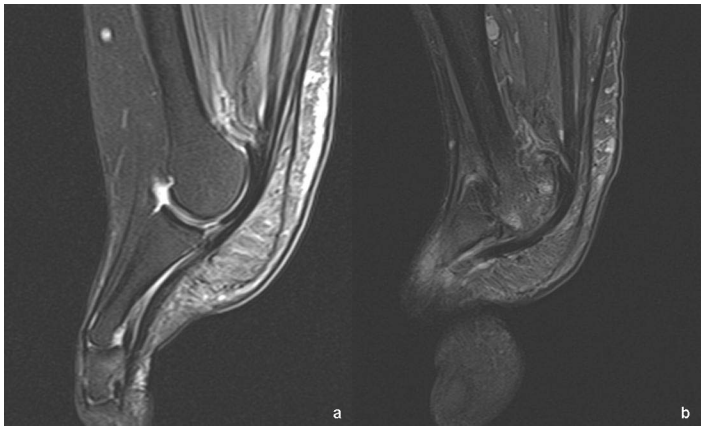

Figure 1a: An intact plantar plate showing continuity with the proximal phalanx. The plantar plate is relatively thin at the insertion, a normal finding.

Figure1b: A full width tear of the plantar plate in RA. There is a large gap between the distal part of the plantar plate and the proximal phalanx. The phalanx is subluxed dorsally. Bone oedema is evident.

References:

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