A comparison of quantitative and semi quantitative MRI assessment of synovitis volume in osteoarthritis of the knee

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Introduction: Osteoarthritis (OA) refers to a heterogeneous group of disorders with common clinical pathological features. It is strongly associated with aging and is the most prevalent joint disease (1,2). The mechanisms of OA pain are not well understood and potential sources of pain include synovitis, subchondral bone abnormalities, meniscal injuries and osteophyte-related periosteal stretching. Recent MR studies on the OA knee have associated the degree of synovial thickening with the severity of knee pain (3). Further studies have described patterns of synovitis within the OA knee, but the relationship of synovial distribution to symptoms is unclear. Measurements of synovial volume are complex and time-consuming. A semi quantitative score has therefore been devised to assess the volume of synovitis in four anatomical sites of the OA knee. The aim of this ongoing study is to compare the semi quantitative synovitis score with a quantitative assessment of synovitis volume.

Methods: 18 patients with clinically diagnosed OA of the knee were assessed for synovitis using gadolinium-enhanced MRI. All patients fulfilled the American College of Rheumatology criteria (clinical and radiographic criteria). MRI of the knee was performed using a Philips 1.5T Gyroscan ACS-NT whole-body scanner (Philips Medical Systems, Best, the Netherlands). A Philips quadrature knee coil was used; the knee was placed in the supine position for imaging. T1 pre and postgadolinium sagittal and coronal images were acquired with the following parameters, repetition time (TR) 604 msec, echo time (TE) 14 msec, slice thickness / slice gap 3mm/ 0.3mm, field of view (FOV) 160, rectangular field of view (RFOV) 80%, matrix size of 256 × 256 and number of signal averages (NSA) 2. For T2W pre gadolinium fat-suppressed (FS) trans images TR 5589msec, TE 100msec, slice thickness / slice gap 3mm /0.3mm, FOV 160, RFOV 80%, matrix size 256 × 256 and NSA 4. For T1W post gadolinium FS trans images TR 650msec, TE 15msec, slice thickness / slice gap 3mm/0.3mm, FOV 160, RFOV 80%, matrix size 256 × 256 and NSA 2. Gadopentetate dimenglumine (Gd-DTPA) was administered by injector pump at 0.2ml(0.1mmol)/kg body weight as a 14 second bolus, post-Gd-DTPA sequences began at four and a half minutes post injection. Four anatomical sites were evaluated: medial and lateral recesses, suprapatellar pouch and intercondylar notch for volume of synovitis. Quantitative assessment of the volume of synovitis was performed by observer 1 (LAR) using the axial T1W post-Gd-DTPA FS images. These were processed using a commercially available image analysis software package Analyze (Analyze-Direct, Lenexa, KS). This software allowed the generation of regions of interest (ROIs) that delineated the enhancing synovium in the four anatomical sites in consecutive slices by manual outlining. The number of enhancing pixels within the ROI was calculated in each slice and converted to an area measurement. The volume of synovitis in each anatomical site was a calculated using the following formula $Vol_{synvol} = \sum (Ar_{synvo} \times ST)$, where ST represents the sum of the slice thickness and the slice gap and Ar_{synvol} represents the area of the synovial volume in each slice (4). The semi quantitative assessment of the volume of synovitis was performed by observer 2 (AJG) using all the conventional T1W and T2W pre and post-Gd-DTPA MR images. Synovitis was scored on a 0-3 basis, where 0 is normal synovium, 1 shows even thickening of the synovium, 2 shows nodular thickening and 3 shows gross nodular thickening of the synovium. Readers were blinded to the results of the comparative study at the time of evaluation.

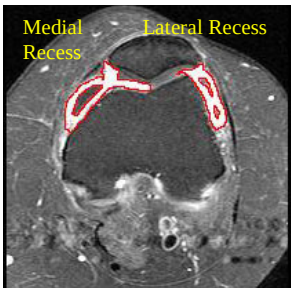

Figure 1: Axial T1-weighted post-Gd-DTPA FS image showing the volume of synovitis in the medial and lateral recess outlined in a single slice.

Results: A total of 72 sites were assessed using both the detailed quantitative and the semi quantitative assessment of the volume of synovitis. Establishment of a correlative relationship was undertaken using Spearman's Rho (ρ) for the combined and individual site specific measurements.

Table 1: Average quantitative volumes of synovitis and equivalent semi quantitative scores for each anatomical site

Semi quantitative		Average Quantitative Volumes of Synovitis / mm^3			
Score	**Evaluation**	**Medial Recess**	**Lateral Recess**	**Suprapatellar Pouch**	**Intercondylar Notch**
0	Normal		-	-	-
1	Even Thickening	5222.48 *(3630 - 7132.38)*	7815.95 *(4353.16 – 10545.82)*	3118.13 *(1095.7 – 6134.65)*	4374.92 *(1945.2 – 6184.92)*
2	Nodular Thickening	9564.20 *(7365.7 – 14177.110)*	8845.29 *(6204.26 – 8404.690)*	5449.39 *(2971.29 – 7707.30)*	7758.44 *(6737.93 - 8891.95*
3	Gross Nodular Thickening	15273.78 (9644.77 – 28162.15)	15039.06 *(9702.77 – 21056.84)*	19529.30 *(13028.55 – 24135.12)*	9448.19 *(6172.03 – 12573.52)*

Maximum and minimum volumes of synovitis of are indicated in parentheses.

The overall correlation for the 'all sites' between the semi-quantitative and detailed volume measurements was moderate (ρ=0.766, N=72, p=0.000), with moderate to good correlations demonstrated across the individual sites. The synovitis measurements at the medial recess demonstrated the strongest correlation (ρ=0.876, N=18, p=0.000), with the intercondylar notch also having good agreement (ρ=0.838, N=18, p=0.000). The suprapatellar pouch measurements had moderate correlation (ρ=0.782, N=18, p=0.000), with the measurements of the lateral recess demonstrating average agreement (ρ=0.632, N=18, p=0.005).

Conclusions: The semi quantitative scoring method correlated well with detailed 'gold standard' volume assessments in this analysis of knees scored to date. This suggests that a convenient and inexpensive quantification of synovitis is feasible.

References:

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