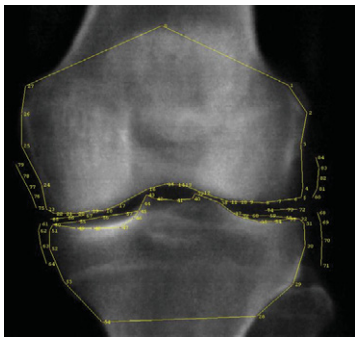

Figure 1

Results: The first 6 out of 15 ASM modes were significantly correlated with KLG; 5 of these remained significant after Bonferroni correction. Two of the first 6 modes were also significantly correlated with age (modes 4 and 5) although, after application of the Bonferroni correction for the number of modes compared ($P<0.0033$), only Mode 5 remained. An increase in KLG was significantly associated with a decreased mode score in modes 1 to 5, and an increase in Mode 6 score (Table 1).

Table 1. Correlation between shape modes and KL

	Mode 1	Mode 2	Mode 3	Mode 4	Mode 5	Mode 6
KL Correlation coefficient	-0.38	-0.48	-0.17	-0.31	-0.28	0.23
P values	<0.001	<0.001	0.013	<0.001	<0.001	0.001
Age Correlation coefficient	-0.16	-0.09	0.04	-0.24	0.33	0.07
P values	0.12	0.37	0.68	0.018	0.001	0.51

A one-way ANOVA (followed by Sidak post-hoc test) was used to explore further the relationship between KLG and each of the first 6 modes of variations. All 6 modes showed an overall significance across the 5 KL grades (Mode 1, 2, 4 and 5 $P<0.001$, Mode 3 $P=0.021$, Mode 6 $P=0.019$). However, the post hoc test identified significant differences in mode scores between different KLG in modes 1, 2, 4, and 5 but not modes 3 and 6.

Osteophyte formation was observed in all six modes although it was more pronounced in Modes 1 and 2. Uniform joint space narrowing was observed in Mode 1 whereas mode 2, 3 and 4 showed unilateral JSN. Variation in the shape of the medial tibial plateau was observed in modes 5 and 6. Similarly variations in condylar shape were observed in modes 2 and 5.

Conclusions: This is the first report on the application of ASM to knee radiographs of patients with Osteoarthritis. The results show clear relationships between the shape of the knee-joint and disease severity. The modes identify variations in osteophytes, joint space narrowing and the size and shape of the condyles and tibial plateau and can distinguish between their unilateral, medial or tibial occurrence.

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DGEMRIC IN THE ANKLE: FEASIBILITY AND PRELIMINARY RESULTS AFTER MATRIX ASSOCIATED AUTOLOGOUS CHONDROCYTE IMPLANTATION (MACI)

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Purpose: Autologous chondrocyte implantation (ACI) techniques aim to prevent early osteoarthritis (OA). Repair tissue (RT) ultra structure influences the long-term clinical outcome. Delayed Gadolinium Enhanced MRI of Cartilage (dGEMRIC) can directly visualize the RT glycosaminoglycan (GAG) content in the knee, however the technique has not been applied to the ankle yet. Clinical studies on cartilage repair in the ankle are limited by numbers and biopsy availability. dGEMRIC is a non-invasive, quantitative measure of repair tissue composition and could enhance clinical research on ACI in the ankle.

This preliminary study aimed to (I) explore the feasibility of dGEMRIC with a high resolution sequence at 3 T in the ankle and (II) to gain first data on the composition of cartilage repair tissue after matrix associated ACI (MACI).

Methods: An isotropic 3D sequence (True FISP) was used to plan the field of view (FOV) of subsequent T1 imaging (voxel size of 0.3×0.3×0.3 mm, FOV 160×150 mm, Averages = 2, TR 9.65 ms, TE of 4.16 ms, acquisition time 9 min 49s). For quantitative T1 mapping a 3D GRE sequence, Volume Interpolated Breathhold Examination (VIBE) was used (TR 15 ms, TE 1.95 ms, FOV 160×160 mm, matrix size 384×384, in plane resolution 0.4×0.4 mm, slice thickness 3 mm, total 16 slices, bandwidth 480 Hz/pixel, flip angles 5° and 26°). The sequence was used both before and after intravenous administration of contrast agent (0.2m M/kg, Magnevist, Schering, Germany).

The interval until complete contrast agent diffusion was determined in volunteers and 45 minutes were found sufficient. Ten patients after ACI and MACI in the ankle were subsequently assessed (Figure 1).

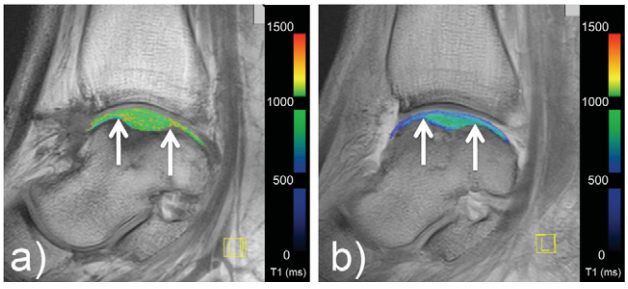

Figure 1. a) Pre contrast, b) post contrast.

T1 map region of interest (ROI) analysis included each one ROI in repair tissue and in normal, hyaline reference cartilage (RC) on contiguous slices to cover the whole repair site. Delta relaxation rates (DR1) of corresponding pre and post contrast ROIs and subsequent individual relative DR1 (rDR1) were calculated for both RT and RC: R1pre = 1/T1pre, R1 post = 1/T1post, DR1 = R1 post - R1pre, rDR1 = DR1 RT/DR1 NC

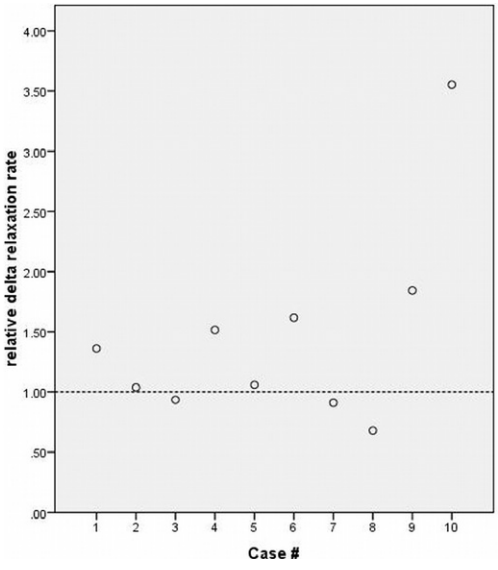

Figure 2

Clinical outcome was assessed with the AOFAS Score at the time of MRI.
Results: We found pre contrast a median T1 of 1056 ms in RC and 1099 ms in RT. Post contrast T1 decreased to 525 ms in RT and 592 ms in RC, respectively. The subsequent DR1 were 1013×10E-6 in RT and 785×10E-6 in RC, resulting in a mean rDR1 of 1.21 (0.68 - 3.55, Figure 2). There was no significant difference between the DR1 of RT and RC (P=0.515). The AOFAS score increased from mean 51±20 (10 - 70) to 84±9.5 (69 - 100) at MRI follow up.
Conclusions: To our knowledge, this study reports the first application of dGEMRIC in the ankle. With the use of a multi-channel coil at 3 T we were able to obtain high resolution T1 maps of the thin cartilage layer of the talus.
We found a wide range in T1 both in RT and RC, however, individual DR1 was comparable. The respective rDR1 indicated that MACI in the ankle can yield RT with a GAG content comparable to that of native, hyaline cartilage.
The most obvious limitation of this preliminary study is the lack of histologic control biopsies, the heterogenous follow up intervals and different ACI techniques in this non-randomized case series.
In summary, dGEMRIC in the ankle was feasible and might improve clinical research in cartilage repair in the ankle.

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ACTIVE APPEARANCE MODELLING OF DXA IMAGES IN THE ASSESSMENT OF KNEE OA

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Purpose: We have shown that Active Shape modelling (ASM) of the hip can identify subjects at greatest risk of developing OA and those who progress most rapidly to a total hip replacement (THR) before clinical signs become apparent. Active Appearance Modelling (AAM) is an extension of ASM that includes the variation of image intensity within a defined shape and describe both (i.e., shape and intensity) in terms of linearly independent variables (modes of variation). Dual energy X-ray absorptiometry (DXA) is used routinely to measure Bone Mineral Density (BMD). DXA images are similar in appearance to a radiograph, though they are generated with a lower radiation dose (typically 1-2% of a pelvic radiograph) and have lower resolution. We have previously shown that DXA images are as useful as radiographs to obtain reproducible Kellgren-Lawrence grade (KLG) scoring. In this study we evaluate their suitability for AAM of the knee in a cohort of volunteers with a range of OA severities.
Methods: The Grampian NHS Radiology Information System was used to identify 107 patients who had had radiographs of both knees taken in the previous 12 months. Volunteers were grouped into severity groups based on their KLG (37 controls, 24 mild OA, 22 moderate OA and 24 severe OA) and received a baseline knee DXA (GE Lunar iDXA). An 85 point AAM template was developed using the AAM toolkit (Manchester University, UK) and Pearson correlations were used to test relationships between mode scores, age and KLG.
Results: Seven of the first 15 modes were significantly correlated with KLG. Only modes 1 to 4, which were not significantly associated with age, remained significant after Bonferroni correction, ($P<0.0033$) (Table 1). A one-way ANOVA (Sidak post-hoc test) was applied to explore further the first 4 modes of variation. This found significant differences between the KLG in all 4 modes ($P<0.01$). Mode 2 had the strongest relationship with KLG ($R=0.68$, $P<0.001$). Post-hoc analysis of Mode 2 identified significant differences between each pair of KL grades (except 3 and 4).

Table 1. Correlations between Mode scores, KL grade and age

Pearson Correlation	Mode 1	Mode 2	Mode 3	Mode 4
KL Correlation Coefficient	-0.20*	-0.68*	0.20*	-0.21*
P value	0.003	<0.001	0.003	0.002

*Significant after Bonferroni correction for t.

Lower mode 2 scores were associated with joint space narrowing, bilateral osteophytes on both the femur and tibia, a wider medial femoral condyle, a shallower intercondylar notch and a more uneven distribution of BMD, particularly in the tibia The lateral tibial plateau was extended beyond the lateral femoral condyle, possibly indicating malalignment (Figure 1).

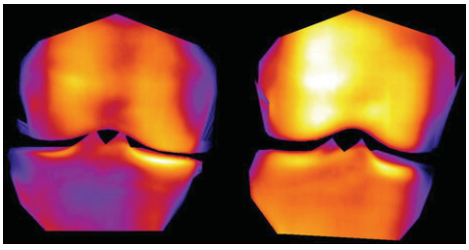

Figure 1

Conclusions: Despite their lower resolution, the image intensity in DXA images is more standardised than plane radiographs, so they are more suitable for AAM of the knee. Accordingly, we have shown that Appearance Models built on knee DXA images have the ability to visualize and quantify bone textural changes indicative of OA severity, suggesting their utility as a potential diagnostic and prognostic imaging biomarker for this disease.

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CHANGE IN HAND PAIN AND FUNCTION AT 18-MONTHS AND 3-YEARS IN RADIOGRAPHIC SUB-GROUPS OF HAND OSTEOARTHRITIS IN COMMUNITY-DWELLING ADULTS AGED 50 YEARS AND OVER

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Purpose: To examine whether radiographic involvement of both the finger and thumb joints, compared with osteoarthritis (OA) of the fingers or thumb only, is associated with an increase in pain and functional limitation, and change in self-reported hand problems at 18-months and 3-years follow-up.
Methods: The clinical assessment study of the hand (CAS-HA) is a prospective population-based cohort of 623 adults aged 50 years and over with self-reported hand pain or hand problems. Dorsi-palmer x-rays of the hands were obtained at baseline and 16 joints in each hand were scored systematically for the presence of OA using the Kellgren and Lawrence (K&L) grading system. For finger joints, radiographic OA was defined as K&L $\geq$2 in one or more finger joints and for radiographic thumb OA as K&L $\geq$2 in one or more thumb joints. Follow-up by postal survey was undertaken at 18-months and 3-years where participants completed a global question on change in their hand condition and the AUSCAN pain and function subscales. Analysis was undertaken to determine the differences between the radiographic sub-groups for global change, pain and function (adjusted for AUSCAN baseline scores).
Results: Of the 623 participants, five did not have x-rays and 26 were excluded due to a diagnosis of an inflammatory arthritis (mean age 64yrs; 62% female). Eligible participants (n=592) were divided into four radiographic sub-groups: no OA (n=107, 18%),