Correlation between BMLs and Quadriceps Arthogenous Muscle Inhibition

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Purpose: Bone marrow lesions (BMLs) visualised on MRI have been implicated in the genesis of pain in knee joint in previous studies. In knee OA, quadriceps weakness is a common clinical feature which is considered to be an important determinant of disability and is due, in part, to arthrogenous muscle inhibition (AMI). AMI has been tied to swelling of the joint and pain but not to specific innervated structures which might lead to spinal level feedback and cause AMI. Given the centrality of BMLs to OA pathology and their neural innervation, we hypothesised patellofemoral joint (PFJ) OA and BMLs may also lead to AMI of the quadriceps. This study correlates the number, size and signal intensity of BMLs in PFJ OA and the percentage of quadriceps AMI, and knee pain scores.

Methods: Subjects were included if they had a K-L score grade 2 or 3 in the PFJ and this was greater than K-L score for the tibiofemoral compartments; aged between 40 -70 years; and had symptomatic PFOA. Their symptoms were reproduced with stair climbing, kneeling, prolonged sitting or squatting or they had lateral or medial patellar facet tenderness on palpation or a positive patellar compression test. Pain was present daily for the previous 3 months and above a score of 4 on a 0-10cm VAS for a nominated activity. BMLs were defined as poorly marginated areas of increased signal intensity in the normally hypointense fatty marrow on fat-suppressed spin-echo images and were graded in each region from 0 to 3 based on the extent of regional involvement; 0= none; 1<25% of the region; 2 =25–50% of the region; 3 =>50% of the region. BMLs in the PFJ were graded in the anterior femur and patella in the medial and lateral PFJ compartment respectively. Scoring was performed by a radiologist who was blinded to the AMI values. AMI data were collected using the twitch interpolation technique by an assessor blinded to the BML scores. The maximal single peak torque value with a 1Hz twitch interpolation and the activation deficit (AD) levels at 100% MVC were calculated as a percentage figure from the ratio: AD= Interpolated twitch torque/Resting twitch torque (ITT / RTT) x 100. Pain was assessed firstly by subjects marking a 10 cm VAS scale (0 = no pain and 10 = worst pain) based on the degree of knee pain they experienced in the previous 7 days using a nominated activity. Secondly, subjects completed the Knee Osteoarthritis Outcome Score (KOOS) pain subscale. Correlation analyses were carried out using a Spearman's rho.

Results: 43 subjects were studied (18 males, 25 females, mean age 54 years, range 43 – 66).Their average AMI was 31.6% (range 7% - 76%). Spearman's rho revealed a significant correlation between the amount of quadriceps AMI and the total volume of BMLs ($r = 0.376$, $P < 0.015$). There was also a significant correlation between AMI and the number of BMLs ($r = 0.325$ $P < 0.038$). There were no significant correlations between pain and AMI (VAS $r = -0.155$, KOOS $r = -0.214$) and between pain and the number of BMLs (VAS $r = -0.179$, KOOS $r = -0.064$).

Spearman's rho		inhibition	number of BMLs	total volume of BMLs	mean overall SI	pain on nominated activity	PainKOOS
inhibition	Correlation Coefficient	1.000	.325(*)	.376(*)	.094	.155	.214
	Sig. (2-tailed)	.	.038	.015	.558	.361	.204
number of BMLs	Correlation Coefficient	.325(*)	1.000	.765(**)	.127	-.179	-.064
	Sig. (2-tailed)	.038	.	.000	.428	.289	.706
total volume of BMLs	Correlation Coefficient	.376(*)	.765(**)	1.000	.007	-.172	-.014
	Sig. (2-tailed)	.015	.000	.	.966	.309	.937
mean overall signal intensity	Correlation Coefficient	.094	.127	.007	1.000	-.187	-.100
	Sig. (2-tailed)	.558	.428	.966	.	.267	.554
pain on nominated activity	Correlation Coefficient	.155	-.179	-.172	-.187	1.000	.617(**)
	Sig. (2-tailed)	.361	.289	.309	.267	.	.000
PainKOOS	Correlation Coefficient	.214	-.064	-.014	-.100	.617(**)	1.000
	Sig. (2-tailed)	.204	.706	.937	.554	.000	.

Conclusions: In subjects with predominant PFJ OA associations have been found between the both number and the area of the BMLs and the quadriceps AMI. These findings indicate that BMLs should be considered as a source of quadriceps AMI and therefore be related to the pathophysiology of the development of OA.