EXTENDED REPORT

Cervical spine magnetic resonance imaging in primary care consulters with shoulder pain: a case–control study

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Objectives: To investigate the association between shoulder region pain presenting in primary care and cervical spine magnetic resonance imaging (MRI) abnormalities.
Methods: A matched case–control study of 48 pairs of participants. Patients had presented to primary care with a new episode of shoulder pain. Controls had no history of pain in the shoulder region and were individually matched with cases by age, gender and referring clinician. All participants underwent a structured clinical assessment and cervical spine MRI. Scans were scored by experienced musculoskeletal radiologists blinded to case–control status.
Results: Median age of participants was 51 years (range 19–79) and 21 (44%) were female. ''Neck pain in the past week'' was reported by 25 (52%) cases and seven (15%) controls (odds ratio, OR, 10.0; 95% confidence interval, CI, 2.4, 88.2). Cervical spine MRI from C3/4 to C6/7 revealed: 18 (38%) of both cases and controls had disc height loss ⩾50% at any level; 10 (21%) cases and eight (17%) controls had disc disease with neural compromise; 11 (23%) cases and 16 (33%) controls had foraminal stenosis; nine (19%) of both cases and controls had canal narrowing. At least one of the above findings was present in 24 (50%) cases and 23 (48%) controls (OR 1.1; 95% CI 0.4, 3.4).
Conclusions: Cervical spine MRI abnormalities were similar in both cases and controls, despite significantly more self-reported neck pain in cases with shoulder pain. Other possible mechanisms, such as muscular strain or postural problems, may explain the observed clinical association between shoulder region pain and neck associated symptoms.

Shoulder and neck problems are common disabling conditions and frequently coexist in primary care consulters;[1–3] 43% of cases with new shoulder region pain also complain of painful or stiff necks.[2] Concomitant neck pain is a risk factor for persistence or recurrence of shoulder symptoms after 1 year; among adults presenting to primary care with shoulder pain, persistent or recurrent pain was almost three times more likely in those with, compared with those without, concurrent neck symptoms.[4] Prospective cohort studies in primary care have highlighted the poor outcome of shoulder region pain, with 40–50% of individuals still symptomatic 12–18 months after onset.[4–6] One reason for this poor long-term outcome might be that despite concurrent symptoms, treatment is often directed solely at the shoulder, and fails to recognise and address coexisting neck problems.

There are several possible explanations for the observed clinical association between neck and shoulder problems. Neural compression at the cervical spine, due to disc disease or foraminal stenosis, can cause pain radiating over the shoulder region and into the affected arm. Symptoms such as pain radiating below the elbow, arm parasthesiae and pain in the shoulder region associated with neck movements are thought to be supportive of the diagnosis of referred neck pain.[7–9] Neural compression may also cause secondary shoulder problems from muscular dysfunction. Conversely, a primary shoulder problem may cause a protective posture, with the affected arm held into the side of the body and the neck flexed towards the painful side, resulting in secondary neck pain. Concomitant shoulder and neck pain may result from a single aetiological mechanism, such as poor posture or what physiotherapists diagnose as ''muscular imbalance''. Finally, it might simply be that people who report pain in one area are more likely to report pain elsewhere.[10]

Degenerative changes of the cervical spine (including disc height loss, root and cord compromise) on magnetic resonance imaging (MRI) are common in subjects with and without a history of neck-related symptoms and increase with age.[11–14] In one study,[12] MRI findings from C2 to T1 considered important (including spurs, disc height loss, neural compromise, foraminal and canal stenosis) were present in 19% of asymptomatic volunteers without a history of cervical spine, shoulder or radicular upper limb symptoms.

In this study we have attempted to address an important clinical question in relation to people presenting to their GP with shoulder pain: Are abnormalities/symptoms of the neck associated with shoulder symptoms? The overall aim of the study was to investigate the association between structural abnormalities and symptoms of the cervical spine and shoulder region pain. The primary objective was to investigate whether adults with shoulder pain are more likely to have cervical spine abnormalities on MRI than adults without shoulder pain. Secondary objectives investigated whether shoulder pain is associated with symptoms of pain and disability of the cervical spine.

METHODS

This was a matched incident case–control study. The cases were subjects who had consulted with shoulder pain in primary care and were a subsample of 180 participants in a cohort study of shoulder questionnaires. Controls were sampled from the same community as the cases. Study information sheets were provided to participants and separate written informed consent

Abbreviations: MRI, magnetic resonance imaging; OR, odds ratio; VAS, visual analogue scale; VAS-OD, visual analogue scale—overall difficulty; VAS-OP, visual analogue scale—overall pain was obtained for the cohort and the case–control studies. The studies were approved by North Staffordshire Local Research Ethics Committee.

Selection of cases and controls

Recruitment of cases to the MRI study was a two-stage process: (1) consent and recruitment to the cohort shoulder questionnaire study, and (2) consent and recruitment to the case–control MRI study.

Stage 1

The recruitment procedure for the questionnaire study has been described elsewhere.[15] Primary care physicians were invited to refer adults with a new episode of shoulder pain to a community-based research clinic. At this clinic, eligible consecutive attenders, who gave written consent, were recruited to the questionnaire study. These participants all had shoulder region pain—defined as pain in the shoulder region brought on or exacerbated by movement of that shoulder. Exclusion criteria included: inflammatory arthropathy; malignancy; polymyalgia rheumatica; fracture of neck or shoulder; subluxation or dislocation of the shoulder; pain of visceral origin; or inadequate cognitive, visual or language skills to complete self-administered health measures.

Stage 2

Questionnaire study participants were screened for eligibility to participate as cases in the MRI study. Inclusion criteria: aged 18 years or above; new episode of shoulder pain (defined as a consultation for a shoulder problem, with no previous consultation for the same problem within the last 6 months); and presence of shoulder region pain at least partly within the area shown in fig 1. Individuals with contraindications to MRI scanning (ferromagnetic implants or foreign bodies, claustrophobia, inability to lie flat for 30 min and unsuitable body habitus for the MRI scanner) or pregnancy were excluded.

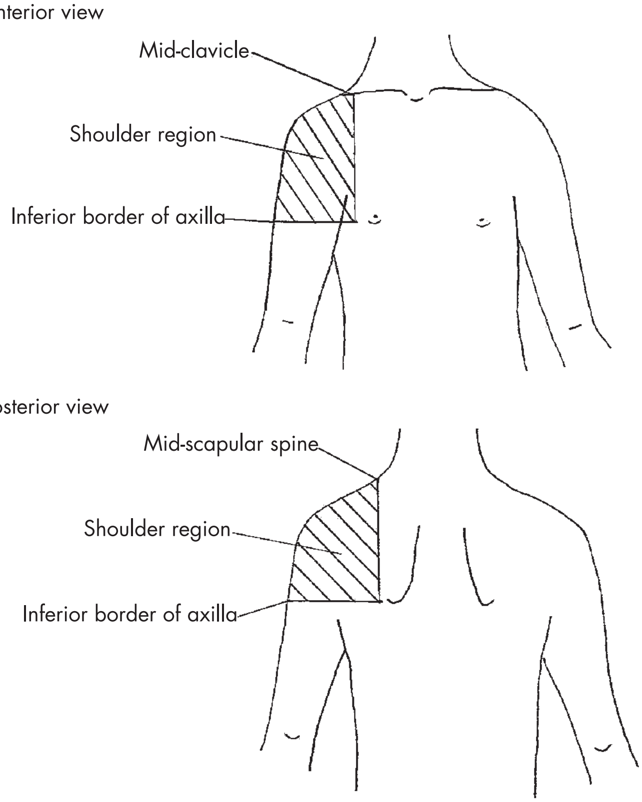

Figure 1 Predefined shoulder region pain.

Potential controls, individually matched by date of birth, gender and referring clinician, were identified from the Local Health Authority patient register. Details of five potential controls per case were provided to the appropriate primary care physicians to allow screening of primary care records to ensure that individuals were still on the registered list of patients and that they were not approached to participate inappropriately (if they had serious comorbidity or mental health problems). Potential eligible controls were contacted in turn by letter and telephoned until one control was identified per case. Potential controls were excluded if: they gave a history of current or previous shoulder complaints; a suspicion of or known malignancy; an inflammatory arthropathy; previous neck fracture or operation; inadequate cognitive, visual or language skills to complete self-administered health measures; contraindications to MRI scanning or pregnancy. Informed written consent was obtained.

Research assessment

At the research clinic, cases with shoulder pain self-completed a generic health measure: EuroQoL (inclusive of EQ-5D and EQ-VAS subscale measures);[16] 10 cm visual analogue scales (VAS) of overall shoulder pain and difficulty (OP and OD); manikins for pain and sensory symptoms; and the Shoulder Rating Questionnaire.[17] In addition, a rheumatology research registrar (AP) carried out a standardised clinical history and examination, based on a previously validated schedule, adopting Health and Safety Executive (HSE) diagnostic guidelines, which has been tested for reliability in a community sample of adults with shoulder pain.[18] Reliability of physical examination of neck movements was also evaluated as part of this study: 21 subjects from primary care physiotherapy with shoulder pain had their neck movements measured independently by two rheumatology research registrars (AP and KWB). Inter-rater agreement, measured by the intraclass correlation coefficient and graded using the classification of Landis and Koch,[19] was ''moderate'' or ''good'' across four active neck movement measures: rotation; flexion; extension; and lateral flexion.

Participants were then given an appointment to attend for MRI scanning of the cervical spine, carried out according to a set protocol.

Controls were also invited to attend the research clinic, where they self-completed EuroQoL and manikins for pain and sensory symptoms. They also underwent a standardised clinical assessment and were given appointments for MRI scanning of the cervical spine.

Participants unable to complete cervical spine scanning (cases or controls) were replaced within the study.

MRI scanning protocol

At the cervical spine, sagittal T1 (TR 600 ms, TE 12 ms) and T2 spin echo (TR 3909 ms, TE 112 ms) and axial T2 gradient echo images (TR 460 ms, TE 22 ms, flip angle 20°) 4 mm thick were obtained using a Siemens Impact I 1.0 Tesla scanner. Sequences were restricted to limit time spent in the scanner by participants. The presence or absence of disc height loss ($<50\%$ or $\geqslant 50\%$); disc protrusion/bulge with or without root and/or cord compromise; foraminal stenosis; and anteroposterior or circumferential canal narrowing were recorded as present/absent at four levels of the cervical spine (C3/4–C6/7).

Scans were scored on a standard proforma, independently by two experienced musculoskeletal radiologists (IM and JS), who were blinded to case–control status. The radiologists reviewed the scores of the first 19 scans together to standardise scoring technique. The remaining 77 scans were scored independently and all individual discrepancies resolved by consensus.

Analysis
The primary outcome (any MRI cervical spine abnormality) was defined as the presence of at least one of the following findings at any level.

- disc height loss ⩾50%
- root and/or cord compression due to disc disease
- foraminal stenosis
- canal narrowing.

Sample size
Assuming a prevalence of "any MRI cervical spine abnormality" in the control population of 20%[12], 48 case–control pairs were required to detect a twofold increase in the prevalence of abnormalities in cases compared with controls (90% power, $\alpha = 0.05$).

External validity
To investigate the external validity of the MRI study, the baseline characteristics of MRI study participants were compared with those of the shoulder questionnaire study participants.

Demographic, clinical and magnetic resonance imaging features of cases and controls
Cases and controls were evaluated using matched case–control methods of analysis. For dichotomous data, case–control pairs were evaluated by calculating estimates of percentage differences or by calculating odds ratio (OR) estimates using the Mantel–Haenszel method for matched case–control analysis (using Fisher's exact confidence intervals). Paired t-tests were performed for continuous data. For the main MRI findings, subgroup analyses were performed for participants stratified by age (⩽50 years, >50 years), gender and concurrent self-reported neck pain in the past week (yes, no) according to the patient questionnaire.

Prognosis of shoulder pain
A subsidiary analysis was undertaken to compare the prognosis of shoulder pain in study subjects with MRI abnormalities of the cervical spine versus without. Data relating to the 6-week follow-up outcome of cases was available as part of the data collected from stage 1 of the study (ie, the shoulder questionnaire study). Outcome measures included perceived change in shoulder pain (five-point ordinal scale, dichotomised as "improved" or "not improved"), VAS-OP; VAS-OD; EuroQoL, and Shoulder Rating Questionnaire. As this analysis was restricted to cases only, it was carried out using unmatched methods. Unadjusted analysis was carried out using the χ^2 test for perceived change and unpaired t-test for the other outcomes; adjusted analysis (adjusting for age and gender) was carried out using logistic and linear regression analyses as appropriate.

Statistical significance was based on a two-tailed level of $\alpha = 0.05$. The statistical packages SPSS v13.0 for Windows and CIA were used for analysis.[20 21]

RESULTS
Participants
A total of 124 participants in the questionnaire study were screened to identify 48 cases for the case–control study: 60 were ineligible, 12 declined and four had contra-indications to the MRI scan. Reasons for ineligibility were self-reported consultation with ipsilateral shoulder pain within 6 months (50), claustrophobia (four), possible inflammatory arthropathy or polymyalgia rheumatica (three), pain not in the manikin defined shoulder region (two) and the presence of a pacemaker (one).

A total of 161 potential controls were identified: 46 declined; 35 had past or present shoulder pain; 21 could not be contacted by phone; nine were claustrophobic; and one had a metal stapes. Forty-eight controls completed the study and one did not (claustrophobia). The number of controls screened per case ranged from one to 10.

External validity
Cases in the cervical spine MRI case–control study were similar in terms of demographic and occupational features, neck-related symptoms and self-completed health measures with those taking part in the questionnaire cohort study (table 1).

Demographic and clinical features of cases and controls
Demographic findings and self-reported symptoms are summarised in table 2. Median age of participants was 51 years (range 19–79), and 21 (44%) were female. Cases and controls were similar with respect to demographic and employment characteristics. Cases reported significantly more neck pain than controls "in the past week" (OR 10.0, 95% confidence interval, CI, 2.4 to 88.2) and "at any other time" (OR 3.6, CI 1.3 to 12.4). The health status of cases was significantly poorer than controls (paired t-test EQ-5D $p<0.001$, EQ-VAS $p<0.01$). On manikin shading, significantly more cases than controls had shaded areas of pain in C4–C7 dermatomes along the affected/matched arm and ipsilateral side of neck.

Examination findings are summarised in table 3. Cervical spine tenderness was elicited in eight (17%) cases and no controls. Neck pain on neck movement was present in 58% of cases and 21% of controls. Differences in neck movement between cases and controls were small (mean difference <10°), but were statistically significant for neck flexion ($p = 0.04$),

Table 1 External validity—comparison of shoulder questionnaire cohort participants with cervical spine MRI study cases

	Questionnaire cohort (n = 180)	MRI study cases (n = 48)
Males/females, no. (%)	90:90 (50:50)	27:21 (56:44)
Age, mean (range) years	54.1 (19–85)	51.8 (19–79)
Usually in paid employment, no. (%)	99 (55)	25 (52)
Work at shoulder level or above, no. (%)	60 (33)	17 (35)
Lift heavy weights at work, no. (%)	72 (40)	17 (35)
Duration of shoulder pain, median (IQR) months	4 (2–6)	3 (2–6)
Neck pain in the past week, no. (%)	93 (52)	25 (52)
Any sensory arm symptoms, no. (%)	84 (47)	22 (46)
Overall difficulty VAS, mean (SD)	55.7 (24.2)	45.0 (25.1)
Overall pain VAS, mean (SD)	59.9 (23.8)	50.5 (21.0)
EQ-5D, mean (SD)	0.52 (0.30)	0.57 (0.27)
EQ-VAS, mean (SD)	65.6 (22.3)	69.5 (21.4)
Shoulder Rating Questionnaire score, mean (SD)	59.5 (16.7)*	56.5 (15.6)

*Summary data for 90 subjects who were allocated the Shoulder Rating Questionnaire (standardised scale: 0–100; 0 = no shoulder pain/disability; 100 = severe shoulder pain/disability).

Table 2 Demographic data, occupational features, manikin findings and self-reported health in age-, sex- and GP-matched cases (consulters with shoulder pain) and controls (no shoulder pain) included in the MRI study

	Cases (n = 48)	Controls (n = 48)
Males/females, no. (%)	27:21 (56:44)	27:21 (56:44)
Age, mean (range)	51.8 (19–79)	52.9 (21–80)
Usually in paid employment, no. (%)	25 (52)	30 (63)
Work at shoulder level or above, no. (%)	17 (35)	17 (35)
Lift heavy weights at work, no. (%)	17 (35)	19 (40)
Neck pain in past week, no. (%)*	25 (52)	7 (15)
Neck pain prior to a week ago, no. (%)*	35 (73)	22 (46)
EQ-5D, mean (SD)*	0.57 (0.27)	0.89 (0.20)
EQ-VAS, mean (SD)*	69.5 (21.4)	78.7 (13.8)
Pain C4, no. (%)*	33 (69)	2 (4)
Pain C5, no. (%)*	41 (85)	0 (0)
Pain C6, no. (%)*	20 (42)	0 (0)
Pain C7, no. (%)*	9 (19)	0 (0)
Pain ipsilateral side of neck, no. (%)*	8 (17)	0 (0)
Pain contralateral side of neck, no. (%)	1 (2)	2 (4)
Pain neck midline, no. (%)	6 (13)	4 (8)
Any sensory arm symptoms, no. (%)*	22 (46)	2 (4)

*p<0.05 by paired case–control analysis.

lateral flexion to the right (p = 0.01) and neck rotation to the left (p = 0.03). The affected shoulders of cases were globally more restricted compared with matched control shoulders, all differences being statistically significant.

MRI findings

Cervical spine MRI abnormalities for the 48 case–control pairs are detailed in table 4. From C3/4 to C6/7: 18 (38%) of both cases and controls exhibited ''any disc height loss ⩾50%''; 10 (21%) cases and eight (17%) controls had ''any disc protrusion/bulge with root and/or cord compromise''; 11 (23%) cases and 16 (33%) controls had ''any foraminal stenosis''; and ''any canal narrowing'' was found in nine (19%) of both cases and controls.

''Any MRI cervical spine abnormality'' at C3–C7 was found in 24 (50%) cases and 23 (48%) of controls (OR 1.13, 95% CI 0.39 to 3.35). There was no significant association between shoulder region pain and any MRI cervical spine abnormality in cases/control pairs stratified by age, gender or the presence/absence of concurrent self-reported neck pain (as reported by cases); though there was reduced statistical power within these subgroups ranging from 61% (for n = 21 pairs) to 70% (for n = 27 pairs).

Table 3 Comparison of clinical examination findings between age-, sex- and GP-matched cases (consulters with shoulder pain) and controls (no shoulder pain) included in the MRI study

	Cases (n = 48)	Controls (n = 48)	Difference (95% CI)
	n (%)	*n (%)*	*% difference*
Neck tenderness	8 (17)	0 (0)	16.7 (5.8, 29.6)*
Neck movement causes neck pain	28 (58)	10 (21)	37.5 (18.8, 52.7)*
	Mean (SD)	*Mean (SD)*	*Mean difference*
Neck flexion (°)	54 (11)	60 (12)	−5 (−10, 0)*
Neck extension (°)	52 (11)	56 (13)	−4 (−9, 1)
Neck lateral flexion left (°)	42 (11)	45 (13)	−3 (−7, 2)
Neck lateral flexion right (°)	40 (10)	45 (12)	−5 (−8, −1)*
Neck rotation left (°)	56 (13)	61 (12)	−5 (−10, −1)*
Neck rotation right (°)	59 (11)	62 (11)	−3 (−7, 1)

*p<0.05 by paired case–control analysis.

Prognosis of shoulder pain

The 24 shoulder cases with MRI neck abnormalities were older (mean, 55.8) and more likely to be male (58%) than the 24 shoulder patients without MRI neck abnormalities; mean age 47.8, and 46% males respectively. Perceived improvement at 6-week follow-up was 70% (16 of 23) in those with MRI abnormalities and 75% (18 of 24) in those without MRI abnormalities. Scores for other shoulder-specific outcomes were slightly higher on average for those with MRI abnormalities compared with those without MRI abnormalities: VAS-OD (mean, 35.3 and 30.4 respectively) and VAS-OP (mean, 34.9 and 32.3 respectively); Shoulder Rating Questionnaire (mean, 47.8 and 38.1 respectively). For the EuroQoL, mean scores at follow-up were lower for cases with MRI abnormalities than for cases without MRI abnormalities: EQ-5D (mean, 0.68 and 0.72 respectively) and EQ-VAS (mean, 70.1 and 72.7 respectively). None of the differences were statistically significant before or after adjustment for age and gender.

DISCUSSION

This study compared cervical spine MRI abnormalities in patients presenting to primary care with a new episode of shoulder pain (cases) with age, gender and referring clinician matched controls selected for no previous history of shoulder problems. We found no association between shoulder region pain and the presence of cervical spine disc narrowing or neural compromise demonstrated by MRI scanning. This was true for the whole sample and for subgroups stratified by age, gender and concurrent neck pain. Among cases, co-occurrence of neck abnormalities was associated with worse 6-week prognosis across all outcomes, though differences were small and not statistically significant.

Primary care physicians were encouraged to refer all patients with a new episode of ''simple'' shoulder region pain to the community research clinic, having excluded those with potentially serious ''red flags''. However, when questioned directly, 50 of 124 potentially eligible patients for the MRI study had reported seeing their general practitioner for the same problem within the previous 6 months. These subjects were therefore excluded from the MRI study. Cases in this study had signs and symptoms of shoulder-related problems: 92% demonstrated signs in keeping with a rotator cuff problem, 42% exhibited positive acromioclavicular signs and 13% had reduced shoulder external rotation (⩽30°).

The strengths of this study lie in its careful case–control design and standardised assessment procedures. Cases and controls were similar with respect to demographic and occupational factors such as being ''usually in paid employment'', having jobs that entailed heavy lifting or working with arms elevated. Hence confounding by known occupational predisposing factors[22] is unlikely. Controlling for ''unknown'' confounders is more problematic but we controlled for differences related to locality and source of health care by identifying controls matched with cases on the basis of their referring primary care physician, as well as by age and gender. We limited potential observer error by the use of a standardised clinical history and examination (previously validated in a community setting),[18] which was carried out by a single observer (AP). Before the study, examination techniques were standardised in a 1-day training session. As patients were

Table 4 Comparison of cervical spine magnetic resonance imaging findings between age-, sex- and GP-matched cases (consulters with shoulder pain) and controls (no shoulder pain) included in the MRI study

	Cases (n = 48)	Controls (n = 48)	Odds ratio (95% CI)
	n (%)	n (%)	
Any disc height loss ⩾50%	18 (38)	18 (38)	1.00 (0.35–2.84)
Any disc protrusion/bulge with compromise	10 (21)	8 (17)	1.33 (0.41–4.66)
Any foraminal stenosis	11 (23)	16 (33)	0.50 (0.13–1.61)
Any canal narrowing	9 (19)	9 (19)	1.00 (0.23–4.35)
Any of the above	24 (50)	23 (48)	1.13 (0.39–3.35)
"Any of the above", subjects ⩽50 years old	8/21 (38)	5/21 (24)	2.50 (0.41–26.3)
"Any of the above", subjects >50 years old	16/27 (59)	18/27 (67)	0.67 (0.14–2.81)
"Any of the above", male subjects	15/27 (56)	15/27 (56)	1.00 (0.23–4.35)
"Any of the above", female subjects	9/21 (43)	8/21 (38)	1.33 (0.23–9.10)
"Any of the above", subjects with concurrent neck pain*	11/25 (44)	11/25 (44)	1.00 (0.27–3.74)
"Any of the above", subjects without concurrent neck pain*	13/23 (57)	12/23 (52)	1.50 (0.17–18.0)

*Presence or absence of neck pain in the past week as self-reported in the patient questionnaire.

recruited from a primary care shoulder clinic it was impractical for this observer to be blinded to case–control status. We minimised potential error during MRI scan reporting by two experienced musculoskeletal radiologists, who were blinded to case–control status, using a standardised scoring system, and scoring the scans independently. Differences between the radiologists were resolved and consensus scores were used for statistical analysis.

One limitation of our study relates to the limited MRI scanning sequences used. For example, foraminal stenosis might have been better assessed by computed tomography or MRI axial T1 sequences, but these approaches increase participant imaging time and/or radiation exposure. For practical reasons we chose to limit the views to reduce respondent burden.

The prevalence of cervical spine MRI abnormalities in our study controls (48%) was high. This raised the possibility of selection bias in that the controls who did participate may have wanted to have a scan because they were aware of some underlying problem with their neck. Although we excluded people with a number of conditions (serious comorbidity, including mental health problems, malignancy, inflammatory arthropathy; a history of current or previous shoulder complaints; previous neck fracture or operation; inadequate cognitive, visual or language skills; contra-indications to MRI scanning; pregnancy) we cannot exclude the possibility that they may have had certain unvoiced concerns. However, only 15% of controls self-reported having neck pain in the past week, which is lower than the 1-month UK prevalence estimate of self-reported neck pain of 31% reported by Hill *et al*,[23] albeit based on a shorter time frame of assessment. The prevalence of abnormalities among controls was higher than that reported by Boden *et al*[12] in "volunteers" (19%); however, direct comparison of the results was problematic because of technical differences in the way in which the scans were carried out and reported. In addition, the volunteer participants in Boden *et al*'s study were younger (mean age 40 years) and without a history of neck symptoms compared with our controls (mean age 51 years) identified from the community, some of who reported a history of neck symptoms. We explored this matter further in the context of this study, and observed that the likelihood of having a "cervical spine MRI abnormality" was greater in participants who had a "history of self-reported neck pain" relative to those with no history of neck pain: unadjusted OR 3.3 ($p = 0.048$); OR 3.2 ($p = 0.079$) after adjusting for age using an unconditional logistic regression analysis.

In summary, this study confirms the association of shoulder region pain with clinical features of cervical spine involvement. However, no association was found between shoulder region pain and structural abnormalities at the cervical spine on MRI scanning. Thus, there is no indication for routine MRI scanning of the neck in patients with predominant shoulder pain.

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