Can ultrasonography improve on radiographic assessment in osteoarthritis of the hands? A comparison between radiographic and ultrasonographic detected pathology

H I Keen, R J Wakefield, A J Grainger, et al.

Ann Rheum Dis 2008 67: 1116-1120 originally published online November 23, 2007

doi: 10.1136/ard.2007.079483

Updated information and services can be found at:

<http://ard.bmj.com/content/67/8/1116.full.html>

These include:

References

This article cites 25 articles, 9 of which can be accessed free at:

<http://ard.bmj.com/content/67/8/1116.full.html#ref-list-1>

Article cited in:

<http://ard.bmj.com/content/67/8/1116.full.html#related-urls>

Email alerting service

Receive free email alerts when new articles cite this article. Sign up in the box at the top right corner of the online article.

Topic collections

Articles on similar topics can be found in the following collections

[Pathology](#) (382 articles)
[Radiology](#) (14940 articles)
[Degenerative joint disease](#) (9464 articles)
[Musculoskeletal syndromes](#) (16878 articles)
[Osteoarthritis](#) (1249 articles)
[Clinical diagnostic tests](#) (18900 articles)
[Radiology \(diagnostics\)](#) (9904 articles)

Notes

To order reprints of this article go to:

<http://ard.bmj.com/cgi/reprintform>

To subscribe to *Annals of the Rheumatic Diseases* go to:

<http://ard.bmj.com/subscriptions>

Can ultrasonography improve on radiographic assessment in osteoarthritis of the hands? A comparison between radiographic and ultrasonographic detected pathology

H I Keen,¹ R J Wakefield,¹ A J Grainger,² E M A Hensor,¹ P Emery,³ P G Conaghan³

¹ Academic Unit of Musculoskeletal Disease, University of Leeds, Leeds, UK; ² Department of Radiology, Leeds Teaching Hospitals NHS Trust, Leeds, UK; ³ Academic Section of Musculoskeletal Disease, University of Leeds, Leeds, UK

Correspondence to: H Keen, Academic Unit of Musculoskeletal Disease, Chapel Allerton Hospital, Chappeltown Road, Leeds LS7 4SA, UK; h.i.keen@leeds.ac.uk

Accepted 1 November 2007
Published Online First
23 November 2007

ABSTRACT

Objectives: Ultrasonography (US) is used in rheumatology to assess small joints in inflammatory arthritis. Recently there has been some investigation into the utility of US in osteoarthritis (OA), however there has been little comparison of US to other imaging modalities in OA. This study aimed to compare the detection of osteophytosis and joint space narrowing (JSN) by US and conventional radiography (CR) in OA of the hand.

Methods: Subjects with OA of the hand underwent US and CR examination of the small joints of both hands to identify osteophytosis and joint space narrowing.

Results: 1106 joints of 37 patients were imaged with US and CR. US detected osteophytosis in 448 joints, compared to CR that detected osteophytosis in 228 joints (approximately 30% fewer joints). Where osteophytosis was detected by US but not CR, this was usually proximal to the joint line. Joint space narrowing was detected in 450 joints by US, but only 261 joints by CR. The distribution of US and CR detected osteoarthritis changes in this cohort was consistent with population studies of radiographic hand OA, although metacarpophalangeal (MCP) involvement was higher than might be expected.

Conclusions: US detected more osteophytosis and joint space narrowing than CR in OA of the hand. Involvement of MCP joints was more common than would be expected from population radiographic studies. The increased detection of OA structural pathology by US may make this a useful tool for hand OA research.

Osteoarthritis (OA) is the most common form of arthritis, and has significant health economic effects in the developed world.^{1–3} The prevalence of radiographic hand OA has been estimated at over 44% in epidemiological studies of elderly populations.⁴ However most population studies have focused on radiographic OA, which may not be reflective of symptomatic or clinically relevant disease.⁵

Recently ultrasonography (US) has been utilised to better understand the disease process in OA.^{6,7} The ability of US to detect structural changes in rheumatic diseases has been validated against other imaging techniques (conventional radiography (CR) and MRI) in inflammatory arthritis.^{8–10} However, there has been little investigation into the validity of US in OA. Whilst there have been reports of changes detected by US,^{6,7,11} there is a paucity of data on the construct validity of US in detecting osteophytes and joint space narrowing in OA. The aim of this study was to compare US-

detected osteophytosis and joint space narrowing in OA of the hand against radiographic assessed osteophytosis and joint space narrowing.

METHODS

Approval for this study was obtained from our local ethics committee, and all patients gave written informed consent. Patients attending the Musculoskeletal Clinics of the Leeds Teaching Hospitals NHS Trust were recruited. Subjects with a clinical diagnosis of symptomatic OA, either meeting ACR criteria for OA, or with symptoms and radiographic structural changes consistent with OA such as sclerosis, joint space narrowing or osteophytes, were included. This allowed inclusion of subjects with base of thumb OA who did not meet American College of Rheumatology (ACR) criteria.¹² Subjects with a diagnosis or clinical suspicion of an inflammatory arthritis, including gout, were excluded. Subjects with radiographic evidence of calcium pyrophosphate deposition were not excluded, as calcium pyrophosphate crystals are increasingly being recognised as evident in OA.¹³

Radiographs

All patients included had recent AP radiographs of both hands. A doctor blinded to US findings (PGC) scored the radiographs for the presence or absence of joint space narrowing and osteophytes, using images from the Osteoarthritis Research Society International (OARSI) atlas.¹⁴ The location of osteophytes was documented as proximal or distal to the joint. Intra-reader reliability was assessed by rescoring the first 10 subjects at least 4 weeks after the initial reading.

US scan

All subjects had an US examination of bilateral first carpometacarpal (CMC) joint, metacarpophalangeal (MCP) joints 1–5, proximal interphalangeal (PIP) joints 1–5 and distal interphalangeal (DIP) joints 2–5 with a Philips HDI 5000 SonoCT scanner (Philips, Eindhoven, The Netherlands). The joints were assessed with a 15–7 MHz “hockey stick” probe in a global fashion (scanning across the longitudinal and transverse planes on the dorsal and palmar surfaces of the hand ensuring the medial and lateral regions of the joints were also visualised). All scans were performed by a single ultrasonographer (HIK). The finger joints were held in neutral position for

scanning, but extended and flexed as required to visualise pathology. Joints were scored for osteophytosis and joint space narrowing. Erosions were not scored due to a previous publication reporting insensitivity of US to erosions compared to CR in OA.¹⁵ Osteophytosis was defined as a cortical protrusion at the joint margin seen in two planes (fig 1). The location of the osteophytosis was recorded as either proximal or distal to the joint. Joint space narrowing was documented as normal when the distances between superficial cortical surfaces of phalanges appeared normal (fig 2). The central portion of the joint cannot be visualised with US, so only the distance between the cortical margin at the superficial aspect of the joint, peripheral can be visualised. The joint space was recorded as “narrowed” when it appeared reduced, or was assumed to be reduced because overlying osteophytes obscure the acoustic window and prevented visualisation of the joint space. The first 10 subjects had their dominant hand scanned 4 weeks after the initial scan to determine intra-reader reliability.

Statistical analysis

The SPSS V.14.0 software package was used for the analysis (SPSS Inc., Chicago, Illinois, USA). The prevalence of radiographic and US osteophytes and joint space narrowing was calculated for each joint. The percentage exact agreement was calculated between US and CR for the presence of osteophytes at each joint, and whether they were proximal or distal to the joint. Intra-reader reliability was assessed by calculating single measure κ values and by determining percentage exact agreement (PEA). Cut-off values have previously been assigned to κ values in an attempt to understand the relevance of the value; these values are somewhat arbitrary, however a value of <0.2 has been considered slight agreement, 0.21–0.4 fair agreement, 0.41–0.6 moderate agreement, 0.61–0.8 substantial agreement and >0.81 almost perfect agreement.¹⁶

RESULTS

A total of 37 subjects with symptomatic hand OA had US and radiographs available for evaluation; 34 subjects met ACR criteria for hand OA and 3 had a clinical diagnosis of OA of the base of thumb. The median age was 57 (IQR 53–66), 31 (83.8%) were female, and the median symptom duration was 50 months (IQR 32–94). One subject was missing 4 joints due to previous amputation of 2 fingers, so 1106 joints were imaged in total

Radiographic findings

Of the 1106 joints imaged, 328 (29.7%) had radiographic osteophytosis; this was seen proximally only in 36 (3.3%) joints and distally only in 175 (15.8%) joints and proximal and distal to the joint in 117 joints (10.6%). The distribution of osteophytosis detected by CR is demonstrated in table 1. Radiographic osteophytosis was seen in 44 CMC joints, 14 MCP

joints, 113 PIP joints and 157 DIP joints. Joint space narrowing occurred in 261 (23.6%) joints, 24 CMC joints, 11 MCP joints, 105 PIP joints and 121 DIP joints. The κ value for intra-reader reliability for the presence of osteophytosis at a given joint was 0.686 (PEA 83.3%), and joint space narrowing 0.659 (PEA 85.8%).

Ultrasonographic findings

Of the 1106 joints scanned, 448 (40.5%) had US osteophytosis. This was seen proximally only in 119 (10.8%) joints, distally only in 82 (7.4%) joints and proximal and distal to the joint in 247 (22.3%). Ultrasound osteophytosis was seen in 42 CMC joints, 38 MCP joints, 180 PIP joints and 188 DIP joints. The distribution of osteophytosis detected by US is demonstrated in table 1. Joint space narrowing was seen in 450 (40.7%) joints, 61 CMC joints, 22 MCP joints, 156 PIP joints and 211 DIP joints. The intra-reader reliability for the presence of osteophytosis at a joint calculated as having a κ of 0.832 (PEA 91.8%); the κ for US-detected joint space narrowing was 0.641 (PEA 82.2%).

Relationship between US and CR findings

Of the 1106 joints, 266 (20.4%) had US and CR osteophytosis, 595 (53.8%) had neither CR nor US osteophytosis, 192 (17.4%) had osteophytosis detected only by US (fig 1), and 53 (4.8%) had osteophytosis detected only by CR. The κ value for agreement between CR and US for osteophytosis was 0.54 with PEA 77.8%. When considering whether osteophytosis occurred at the proximal or distal side of the joint, agreement between US and CR occurred in 854 (77.2%) and 887 (80.2%) joints respectively. US detected proximal osteophytosis in 243 joint osteophytes where it was not detected by CR, and CR detected proximal osteophytosis in 29 joints not identified by US. Ultrasound detected osteophytosis distally in 135 joints not detected by CR, and CR detected osteophytosis in 84 joints not detected by US. The comparative distribution of US and CR detected osteophytes is presented in table 1.

Joint space narrowing was detected in 215 (19.4%) joints by US and CR, in 46 (4.2%) joints by CR alone and 235 (21.2%) joints by US alone. The κ value for agreement between US and CR for joint space narrowing was 0.436 with a PEA of 74.6%. The distribution of joint space narrowing as determined by US and CR is shown in table 2.

Although we had predetermined that erosions would not be scored, a recent publication¹⁷ prompted a decision post hoc to score erosions seen on CR. Radiographic erosions were documented in six joints (0.5%) by CR, occurring in five subjects. Joints with erosions included three PIPs, two DIPs and one MCP. The US scores were reviewed, and two of these joints appeared normal on US; however, four were severely damaged with marked osteophytosis and joint space narrowing.

Figure 1 Right second proximal interphalangeal joint. A. The radiograph demonstrates a normal joint, the location of osteophyte seen on ultrasonography is circled. Dorsal longitudinal (B) and dorsal transverse (C) ultrasound images clearly demonstrate a dorsal proximal osteophyte (arrows). PP, proximal phalanx; MP, middle phalanx.

Extended report

Figure 2 A. Radiograph of a left fourth distal interphalangeal (DIP) joint with joint space narrowing. B. Ultrasound image (dorsal longitudinal) of the same joint demonstrating joint space narrowing as detected by ultrasound (US). Note the close proximity of the cortical surfaces of the middle and distal phalanges (arrows). C. Left fourth DIP in an asymptomatic volunteer demonstrating normal space between the middle and distal phalanx (arrows). MP, middle phalanx; DP, distal phalanx.

DISCUSSION

This is the first study describing the relationship between US and CR detected osteophytes, although US-detected osteophytes have been described in review publications.^{11–18} The distribution of osteophytic changes found by US and CR in this cohort is consistent with studies of radiographic hand OA.^{19–22} Whilst US detected more changes than CR, the pattern of joint involvement was similar for both modalities.

The most surprising finding was osteophytosis in 10.3% of MCP joints, as population studies report an incidence of MCP radiographic changes in the region of 5%.²² In particular involvement of the first right MCP was prevalent. This is interesting given that OA of the hand has historically been considered to be a result of genetic and metabolic factors, rather than biomechanical factors. However, recent population studies of radiographic hand OA have demonstrated a predominance of radiographic changes in joints thought to have higher biomechanical stress.^{22–24} Likewise, epidemiological studies of hand OA from China and Japan have demonstrated an increased incidence of disease in the right IP and second DIP, presumably due to chopstick use.^{22–23} The increased rate of detection of changes in this joint by US compared to CR demonstrated in this study may be related to anatomical rotation of the joint, and the ability of US to image the joint in multiple planes rather than the standard AP plane depicted by CR. Utilising CR to determine the prevalence of OA may have resulted in underestimation of the prevalence of OA at this joint.

Interestingly, US improved detection of osteophytosis proximal to the joint compared to CR. In this cohort, radiographically detected osteophytes were seen more often distal to the joint, whereas by US osteophytosis were seen in approximately equal frequency proximally and distally to the PIP and DIP joints. However, at the MCP and CMC joints osteophytes were seen more commonly proximally by US, but distally by CR. In our study US osteophytes were seen relatively uniformly around the DIP and PIP joints, whereas CR osteophytes were

seen largely distally. Recently Tan *et al* reported that MRI detected osteophytes in the DIP and PIPs tend to occur proximally.²⁵ The contrasting findings between the location of MRI osteophytes found by Tan, and US osteophytes in this study, may be due to differences in the numbers of joints imaged or populations studied. This study examined 1106 joints of subjects with established hand OA, whereas Tan examined 58 joints of subjects who predominantly had early OA and only studied DIP and PIPs. In agreement with Tan's findings, this study suggests CR may underestimate the prevalence of proximal osteophytosis, although it is difficult to determine from radiographic epidemiological studies the exact location of osteophytes.¹⁹ In the present work, the agreement between US and CR as to the presence of osteophytes at a given joint and to the location in regards to the joint was moderate (κ 0.54), although the percentage exact agreement was very good. The increased detection of osteophytosis by US is most likely due to ability of US to examine the joint in multiple planes, in contrast to the two dimensional nature of CR. For example, osteophytes that are small and localised to either the dorsal or palmar aspect of the joint (fig 1) are unlikely to be visualised on a standard AP radiograph of the hand.

This study has limitations, relating to US itself and the study design. Only osteophytes and joint space narrowing in OA (features that US and CR can image) were compared. Estimating joint space abnormalities with US is problematic as the central portion of the joint cannot be visualised by US, and osteophytes blocking the acoustic window often prevent the joint space being adequately visualised; for the purposes of this research, this was recorded as narrowed. Indeed, a surrogate of joint space narrowing was often scored in this study.

Bone sclerosis, bone cysts and erosions are pathological features commonly seen radiographically in OA that were not examined, as US cannot visualise these features well. Due to the intrinsic nature of B mode US, subchondral sclerosis or bone cysts cannot be reliably demonstrated. Erosions were not scored

Table 1 Total number of joints with osteophytes as imaged on ultrasound (US) or conventional radiography (CR)

Left hand					Joint	Right hand				
5	4	3	2	1		1	2	3	4	5
20	19	30	30		DIP US osteophytes		27	27	21	23
23	16	22	22		DIP CR osteophytes		22	21	9	17
15	17	18	17	24	PIP US osteophytes	22	20	15	14	18
12	9	13	13	10	PIP CR osteophytes	11	12	9	10	11
1	0	2	9	10	MCP US osteophytes	7	6	2	1	0
0	1	4	2	1	MCP CR osteophytes	3	1	1	0	0
				21	CMC US osteophytes	22				
				23	CMC CR osteophytes	21				

CMC, carpometacarpal joint; DIP, distal interphalangeal joint; PIP, proximal interphalangeal joint; MCP, metacarpophalangeal joint.

Table 2 Total number of joints with joint space narrowing detected by conventional radiography (CR) and ultrasound (US)

Left hand					Joint/imaging modality	Right hand				
5	4	3	2	1		1	2	3	4	5
28	19	26	24		DIP US JSN		30	32	28	24
13	16	15	16		DIP CR JSN		16	16	14	15
14	13	14	17	15	PIP US JSN	19	15	15	17	17
13	10	10	12	7	PIP CR JSN	6	9	10	13	15
0	0	0	3	6	MCP US JSN	5	4	3	0	1
0	0	0	1	1	MCP CR JSN	2	4	2	1	0
				29	CMC US JSN	32				
				12	CMC CR JSN	12				

CMC, carpometacarpal joint; DIP, distal interphalangeal joint; JSN, joint space narrowing; PIP, proximal interphalangeal joint; MCP, metacarpophalangeal joint.

in this study by US, as US has been shown to be less sensitive to erosions than CR in hand OA.¹⁵ In addition, practical problems occur in trying to classify cortical irregularities as osteophytes or erosions in very damaged joints. Cartilage abnormalities were not scored. Once again, given current technology, US related cartilage qualification and quantification in the small joints of the hand is problematic due to image resolution, the inability to visualise cartilage in the central portion of the joint and the effect of osteophytes shadowing the cartilaginous surface of the joint. Even when joints are flexed, large osteophytes are likely to shadow the articular cartilage.

It must be remembered that standard AP radiographs of the hand will produce a two-dimensional image that, we would hypothesise, will detect osteophytes on the medial or lateral surface of the joint, but not osteophytes localised to the dorsal or palmar surface of the joint (unless there is considerable lateral spread of the lesion). Given US is able to image the joint in multiple planes, including the dorsal, palmar and lateral surfaces of the joint, it is perhaps not surprising that US detects more osteophytosis than CR. This study compared only the presence of osteophytosis at a given joint, and whether it was proximal or distal, as detected by US and by CR. What was found was that US detected more osteophytosis, but that in most cases there was agreement between US and CR as to the presence or absence of osteophytosis. What cannot be determined from this study is if the two techniques were imaging exactly the same lesion or osteophyte.

In examining the role of US in detecting osteophytosis, validation against a gold standard such as computer tomography or histology would be ideal, and perhaps address the issue of whether exactly the same lesion is being visualised with each modality. However, in clinical practice, the standard AP hand film is routinely used to confirm the diagnosis of OA. We chose to compare US to the standard CR view, as US is also a clinically feasible imaging technique that could be applied to confirm the diagnosis of OA with a potential for increased sensitivity whilst avoiding radiation exposure. However, the lack of validation against a gold standard means that the results should be interpreted with caution, and the detection of pathological changes by US, particularly joint space narrowing due to the problems in the US definition, could possibly be overestimated.

We have demonstrated that US detects more osteophytosis and joint space narrowing than the current standard imaging technique, especially at the MCP joints and proximally. We have also found in our cohort that MCP involvement was more frequent than would be expected from epidemiological studies. Utilising US in OA of the small joints of the hand may aid

observation of OA characteristics and clinical management of patients with hand symptoms. Further investigation in to the ability of US to identify early disease will become more important as more effective therapies for osteoarthritis become available.

Competing interests: None declared.

Ethics approval: Approval for this study was obtained from our local ethics committee (Leeds, UK), and all patients gave written informed consent.

REFERENCES

1. **Rabenda V**, Manette C, Lemmens R, Mariani A-M, Struyv N, Reginster J-Y. Direct and indirect costs attributable to osteoarthritis in active subjects. *J Rheumatol* 2006;**33**:1152–8.
2. **Xie F**, Thumboo J, Fong K-Y, Lo N-N, Yeo S-J, Yang K-Y, *et al*. Direct and indirect costs of osteoarthritis in Singapore: a comparative study among multiethnic Asian patients with osteoarthritis. *J Rheumatol* 2007;**34**:165–71.
3. **Le Pen C**, Reygobellet C, Gerentes I. Financial cost of osteoarthritis in France. The "COART" France study. *Joint Bone Spine Rev Rhumatisme* 2005;**72**:567–70.
4. **Zhang Y**, Xu L, Nevitt MC, Niu J, Goggins JP, Aliabadi P, *et al*. Lower prevalence of hand osteoarthritis among Chinese subjects in Beijing compared with white subjects in the United States: the Beijing osteoarthritis study. *Arthritis Rheum* 2003;**48**:1034–40.
5. **Dahaghin S**, Bierma-Zeinstra SM, Ginai AZ, Pols HA, Hazes JM, Koes BW. Prevalence and pattern of radiographic hand osteoarthritis and association with pain and disability (the Rotterdam study). *Ann Rheum Dis* 2005;**64**:682–7.
6. **D'Agostino MA**, Conaghan P, Le Bars M, Baron G, Grassi W, Martin-Mola E, *et al*. EULAR report on the use of ultrasonography in painful knee osteoarthritis. Part 1: prevalence of inflammation in osteoarthritis. *Ann Rheum Dis* 2005;**64**:1703–9.
7. **Naredo E**, Cabero F, Palop MJ, Collado P, Cruz A, Crespo M. Ultrasonographic findings in knee osteoarthritis: a comparative study with clinical and radiographic assessment. *Osteoarthritis Cartilage* 2005;**13**:568–74.
8. **Wakefield RJ**, Gibbon WW, Conaghan PG, O'Connor P, McGonagle D, Pease C, *et al*. The value of sonography in the detection of bone erosions in patients with rheumatoid arthritis: a comparison with conventional radiography. *Arthritis Rheum* 2000;**43**:2762–70.
9. **Szkudlarek M**, Narvestad E, Klarlund M, Court-Payen M, Thomsen HS, Ostergaard M. Ultrasonography of the metatarsophalangeal joints in rheumatoid arthritis: comparison with magnetic resonance imaging, conventional radiography, and clinical examination. *Arthritis Rheum* 2004;**50**:2103–12.
10. **Szkudlarek M**, Klarlund M, Narvestad E, Court-Payen M, Strandberg C, Jensen KE, *et al*. Ultrasonography of the metacarpophalangeal and proximal interphalangeal joints in rheumatoid arthritis: a comparison with magnetic resonance imaging, conventional radiography and clinical examination. *Arthritis Res Ther* 2006;**8**:R52.
11. **Grassi W**, Filippucci E, Farina A, Cervini C. Sonographic imaging of the distal phalanx. *Semin Arthritis Rheum* 2000;**29**:379–84.
12. **Altman R**, Alarcon G, Appelrouth D, Bloch D, Borenstein D, Brandt K, *et al*. The American College of Rheumatology criteria for the classification and reporting of osteoarthritis of the hand. *Arthritis Rheum* 1990;**33**:1601–10.
13. **Fuerst M**, Lammers L, Schäfer FKW, Peter D, Dreimann M, Echtermeyer F, *et al*. Prevalence and structure of calcium crystals in advanced osteoarthritis (OA) of the knee. *Ann Rheum Dis* 2007;**66**(Suppl 2):498.
14. **Altman RD**, Gold GE. Atlas of individual radiographic features in osteoarthritis, revised. *Osteoarthritis Cartilage* 2007;**15**(Suppl 5):1–56.
15. **Iagnocco A**, Filippucci E, Ossandon A, Ciapetti A, Salaffi F, Basili S, *et al*. High resolution ultrasonography in detection of bone erosions in patients with hand osteoarthritis. *J Rheumatol* 2005;**32**:2381–3.
16. **Landis RJ**, Koch GG. The measurement of observer agreement for categorical data. *Biometrics* 1977;**33**:159–74.

Extended report

17. **Grainger AJ**, Farrant JM, O'Connor PJ, Tan AL, Tanner S, Emery P, *et al*. MR imaging of erosions in interphalangeal joint osteoarthritis: is all osteoarthritis erosive? *Skeletal Radiol* 2007;**36**:737–45.
18. **Gibbon WW**, Wakefield RJ. Ultrasound in inflammatory disease. *Radiologic Clin N Am* 1999;**37**:633–51.
19. **Zhang Y**, Niu J, Kelly-Hayes M, Chaisson CE, Aliabadi P, Felson DT. Prevalence of symptomatic hand osteoarthritis and its impact on functional status among the elderly: the Framingham study. *Am J Epidemiol* 2002;**156**:1021–7.
20. **Haara MM**, Manninen P, Kroger H, Arokoski JP, Karkkainen A, Knekt P, *et al*. Osteoarthritis of finger joints in Finns aged 30 or over: prevalence, determinants, and association with mortality. *Ann Rheum Dis* 2003;**62**:151–8.
21. **Wilder F**, Barrett J, Farina E. Joint-specific prevalence of osteoarthritis of the hand. *Osteoarthritis Cartilage* 2006;**14**:953–7.
22. **Toba N**, Sakai A, Aoyagi K, Yoshida S, Honda S, Nakamura T. Prevalence and involvement patterns of radiographic hand osteoarthritis in Japanese women: the Hizen-Oshima Study. *J Bone Miner Metabol* 2006;**24**:344–8.
23. **Hunter DJ**, Zhang Y, Nevitt MC, Xu L, Niu J, Lui LY, *et al*. Chopstick arthropathy: the Beijing Osteoarthritis Study. *Arthritis Rheum* 2004;**50**:1495–500.
24. **Neame R**, Zhang W, Deighton C, Doherty M, Doherty S, Lanyon P, *et al*. Distribution of radiographic osteoarthritis between the right and left hands, hips, and knees. *Arthritis Rheum* 2004;**50**:1487–94.
25. **Tan AL**, Toumi H, Benjamin M, Grainger AJ, Tanner SF, Emery P, *et al*. Combined high-resolution magnetic resonance imaging and histological examination to explore the role of ligaments and tendons in the phenotypic expression of early hand osteoarthritis. *Ann Rheum Dis* 2006;**65**:1267–72.

Save your favourite articles and useful searches

Use the “My folders” feature to save and organise articles you want to return to quickly—saving space on your hard drive. You can also save searches, which will save you time. You will only need to register once for this service, which can be used for this journal or all BMJ Journals, including the BMJ.