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Radiological assessment of haemophilic arthropathy with emphasis on MRI findings

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Summary. Medical imaging of haemophilic joints is important for detecting abnormalities, grading their severity and selecting the appropriate therapy. The plain-film scoring systems for staging joint disease that were developed prior to the availability of magnetic resonance imaging (MRI) are inadequate for planning modern prevention and treatment. MRI is capable of delineating all of the soft tissue findings long before they are evident on plain radiographs. In this paper, an MRI scoring system is presented along with examples of joint effusion, haemarthrosis, synovial hypertrophy, haemosiderin deposition, erosions, cysts and cartilage loss. MRI is a powerful tool in the diagnosis, staging and treatment of patients with haemophilic joint disease.

Keywords: cartilage loss, haemophilia, joint disease, MRI, staging systems, synovitis

Introduction

The development of advanced imaging methods for detecting haemophilic joint disease has paralleled advances in treatment. There is hope that genetic manipulation may cure or alter the expression of recurrent bleeding episodes [1]. In the meantime, there are logistic and economic issues related to prophylaxis [2,3]. Magnetic resonance imaging (MRI) can help in determining the stage of the joint disease and the selection of patients for prophylaxis, ie MRI can tell whether there is active bleeding in the joint, chronic synovitis with effusion or fibrosis with a contracted joint.

Animal studies have shown that the earliest effect of bleeding in the joint is on the articular cartilage [4]. However, in clinical practice the earliest changes that can be seen on imaging are in the synovium [5]. Recurrent bleeding tends to occur in predictable patterns. Most people with severe haemophilia have multiple target joints that tend to bleed asymmetrically and episodically so that, over time, one joint may stop bleeding and another commence. The common target joints are the knee, ankle and elbow.

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Traditional imaging methods

Treatment options at all stages of disease may be influenced by imaging findings [6,7]. In order to stage the progression of joint disease and select the appropriate therapy, two imaging classification systems of haemophilic joint disease were developed in the 1970s [8,9]. These systems depend on the presence of abnormalities on conventional radiographs. The Arnold–Hilgartner scale, frequently used in the USA, is progressive in the sense that the final score is given for the worst findings in the joint as one advances through the stages of the disease (Table 1). On the other hand, the Pettersson score, part of a detailed clinical and radiological classification of the haemophilic joint that was adopted by the World Federation of Haemophilia, is additive (Table 2). This means that joint abnormalities at various stages may be present at the same time in a single target joint, and the presence of a more advanced disease finding does not preclude the presence of an earlier finding. For example, patients with cartilage loss are considered to be at an advanced stage of the disease in both scoring systems. However, the Pettersson system would generate a higher score for patients who have cysts and erosions in addition to cartilage loss than for those with only end-stage cartilage loss. Also, the Pettersson system does not attempt to evaluate the presence of soft tissue changes because of the difficulties inherent in trying to separate out various soft tissues that have similar physical

Table 1. Arnold-Hilgartner scale.

Stage	Findings
0	Normal joint
I	No skeletal abnormalities; soft tissue swelling present
II	Osteoporosis and overgrowth of epiphysis; no cysts; no narrowing of cartilage space
III	Early subchondral bone cysts; squaring of the patella; notch of distal femur or humerus widened; preservation of cartilage space
IV	Findings of stage III more advanced; cartilage space narrowed
V	Fibrous joint contracture; loss of joint cartilage space; extensive enlargement of the epiphysis and substantial disorganization of joint

Adapted from [8].

Table 2. Pettersson score.

Type of change	Finding	Score
Osteoporosis	Absent	0
	Present	1
Enlarged epiphysis	Absent	0
	Present	1
Irregular subchondral surface	Absent	0
	Partially involved	1
	Totally involved	2
Narrowing of joint space	Absent	0
	Joint space >1 mm	1
	Joint space ≤1 mm	2
Subchondral cyst formation	Absent	0
	1 cyst	1
	>1 cyst	2
Erosion of joint margins	Absent	0
	Present	1
Gross incongruence of articulating bone ends	Absent	0
	Slight	1
	Pronounced	2
Joint deformity (angulation and/or displacement between articulating bones)	Absent	0
	Slight	1
	Pronounced	2
Possible joint score		(0–13)

Adapted from [9].

densities on conventional radiographs. Therefore, no comment is made about the possibility of a joint effusion or synovitis. A modification of these plain film scores was proposed in 1989 that claimed to be as sensitive as the Pettersson method but simpler to use [10]. However, in practice, physicians tend to use the two earlier scoring methods.

Advanced imaging modalities

Radionuclide studies in the form of bone scans have been used to survey for the presence of inflammation around peripheral joints [11,12]. This method allows a quick look at the entire skeleton but lacks spatial resolution. Bone mineral density studies with quantitative computed tomography or dual-energy X-ray scanning will show decreased bone density either from chronic illness or relative immobilization. Studies in children with haemophilia have looked at the effects of osteoporosis [13]. Sonography of the joints is a technology that has enjoyed more popularity in Europe and Canada than it has in the USA [14,15]. It has the advantages of being cheap, easily incorporated into an office practice and noninvasive. The main disadvantages are that it takes considerable experience to become expert using this 'hands-on' technology, and spatial and tissue resolution are not as good as MRI. Sources of error in musculoskeletal ultrasound have been documented [16].

MRI offers an appealing alternative as an imaging modality. Many studies have reported on the efficacy of imaging haemophilic joint disease with MRI [17–19]. Specific injuries better seen with MRI include joint effusion/haemarthrosis, synovial hyperplasia/haemosiderin deposition, marginal erosions/subchondral cysts and, to some degree, articular cartilage loss/degenerative joint disease.

MRI parameters

Blood products have variable MR signal depending on the age of the bleeding event. Very early bleeding may have a high signal on T1 and T2 weighted images. As the blood ages it becomes deposited in the synovial lining as haemosiderin, which has a low signal on both T1 and T2 [20]. In order to enhance the conspicuity of haemosiderin, and to allow adequate visualization of articular cartilage, gradient echo imaging of these joints has been advocated by Rand *et al*. [21]. The magnetic susceptibility artifact that is present in gradient echo images causes iron-containing substances to appear intensely black (low signal). These same authors also wrote about the utility of intravenous gadolinium contrast enhancement for seeing the effects of synovitis, both in terms of the synovial hypertrophy and the production of joint fluid [21].

Joint effusion/haemarthrosis

Most joint effusions will have MR signal characteristics of water, with low signal on T1 images and high signal on T2 (Fig. 1). As mentioned above, bleeding in the joint may be distinguished from water by the fact that acute bleeding may have the characteristic of being high signal on both T1 and T2. On gradient echo imaging it may be possible to

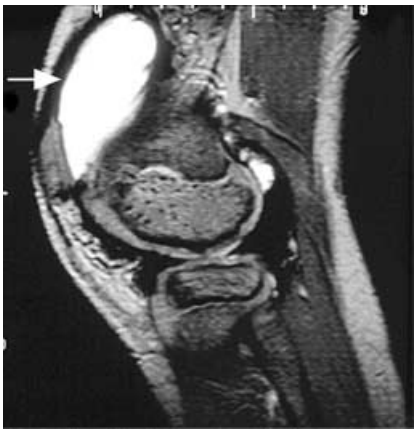

Fig. 1. A sagittal, gradient echo MR image of the knee shows a moderate joint effusion manifested by a high signal within the suprapatellar bursa (arrow).

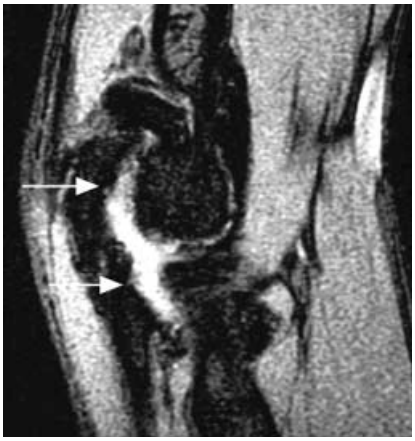

Fig. 2. Bloody effusion is uncommonly seen on MR of haemophilic joints. This is an example on a gradient echo image of intermediate signal fluid compatible with extracellular methemoglobin in the elbow joint (upper arrow, haemoglobin; lower arrow, fluid).

distinguish blood in the joint fluid from non-haemorrhagic synovial fluid by the lower signal of blood (Fig. 2).

Synovial hyperplasia/haemosiderin deposition

The key to the successful early treatment of haemophilic joint disease is the recognition of synovial hyperplasia. This can develop after only one or a few bleeding episodes. The amount of synovial hypertrophy can be quantified, although this is not easy. Methods of quantification usually involve drawing a region of interest measurement (an area) on a given MR slice. These areas can then be summed on contiguous slices to form a volume estimate [22]. As an alternative to this, a semiquantitative Denver scale has been developed to describe the various components of haemophilic joint disease [23] (Table 3). Synovial hyperplasia is ranked as 'absent, small, moderate or large' on the MR slice showing the most severe findings (Figs 3 and 4). Most of these synovial deposits have haemosiderin within them. This fact is in contrast to what is seen in most other synovial inflammatory processes, such as juvenile rheumatoid arthritis. Prognostically, the presence or absence of haemosiderin does not appear to be as important as the amount of synovial hyperplasia that is present.

Table 3. Denver MRI scale.

	Finding	Score
Effusion	Absent	0
	Small	1
	Moderate	2
	Large	3
Haemarthrosis	Absent	0
	Small	1
	Moderate	2
	Large	3
Synovial hyperplasia	Absent	0
	Small	4
	Moderate	5
	Large	6
Haemosiderin	Absent	0
	Small	4
	Moderate	5
	Large	6
Erosion	Absent	0
	Partial surface erosion	7
	Full surface erosion	8
Subchondral cyst	Absent	0
	1 cyst	7
	>1 cyst	8
Cartilage loss	Absent	0
	Less than 50% loss	9
	50% or greater loss	10
Ancillary findings on Denver MRI scale		
Pseudotumour	Absent	
	Present	
Osteonecrosis	Absent	
	Present	
Fibrocartilage tear (applies to knee)	Absent	
	Present	
Ligament tear	Absent	
	Present	
Loose body	Absent	
	Present	

MRI score, highest number in any category. Adapted from [23].

Marginal erosions/subchondral cysts

As mentioned above, blood in the joint has an early adverse effect on articular cartilage and marginal

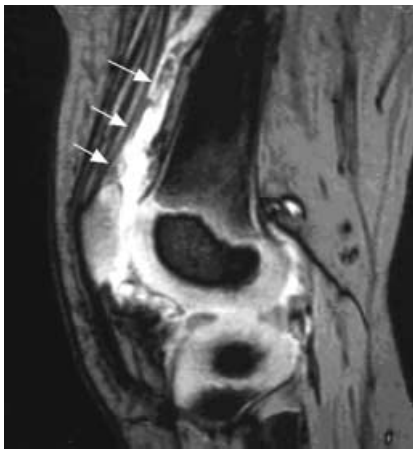

Fig. 3. Small synovial hyperplasia shows an intermediate signal on this gradient echo sagittal image of the knee (arrows).

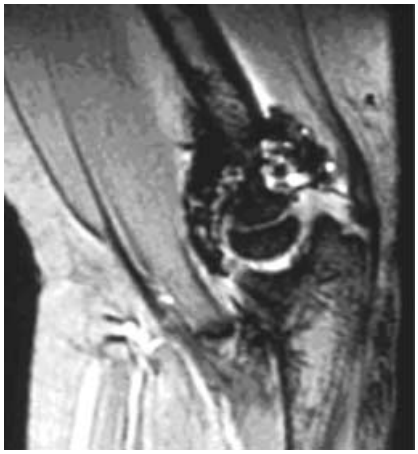

Fig. 4. Much larger synovial hyperplasia with haemosiderin deposition is manifest by low signal material within the elbow joint on this sagittal gradient echo image.

bone. Similar to rheumatoid arthritis, erosions can occur either before or at the same time that the articular cartilage is destroyed (Fig. 5). Subchondral cysts develop because of the intrusion of synovium through fissures in the articular cartilage. Some of the cysts contain only fluid (Fig. 6), while others have irregular low-signal areas that are presumably synovium (Fig. 7). In terms of quantifying these changes, the Denver score mentioned above uses the terms 'partial' and 'full' surface erosions, defined as less than 50% of the transverse articular surface of the joint affected on a coronal image in the case of partial erosions, and 50% or greater involvement in the case of full surface erosions. 'One' or 'more than one' subchondral cysts are ranked separately [23].

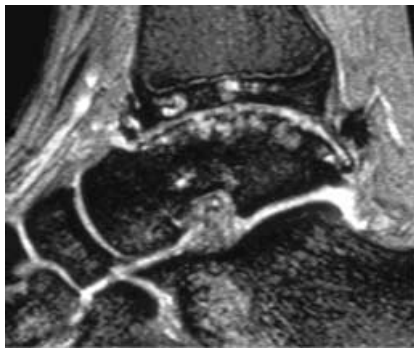

Fig. 5. Marginal erosions have destroyed much of the cartilage and bone on this sagittal gradient echo image of the ankle joint.

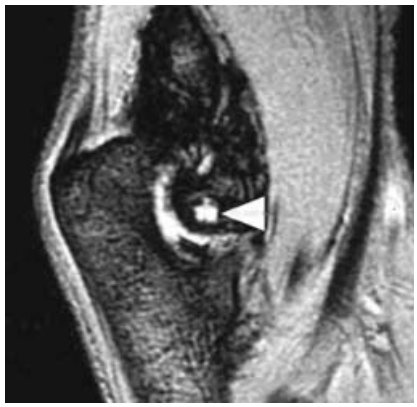

Fig. 6. A subchondral cyst is present in the distal humerus on this sagittal gradient echo image of the elbow (arrowhead). The high signal indicates the presence of synovial fluid.

Articular cartilage loss/degenerative joint disease

These findings are usually well seen on conventional radiographs and form part of the grading systems developed by Arnold–Hilgartner and Pettersson. Early stages of articular cartilage loss may be difficult to see both on radiographs and MRI. Various MR methods have been developed for visualizing cartilage [24,25]. We prefer gradient echo imaging because it is fast, has adequate spatial resolution, can be obtained on most clinical MR scanners and can show haemosiderin and articular cartilage (Fig. 8). In young patients, where the secondary epiphyseal growth cartilage is large, it may be difficult to tell the enchondral cartilage of the secondary ossification centre from the overlying articular cartilage, but gradient echo imaging seems to be useful. In terms of grading the severity of the articular destruction, plain films are valuable. The Denver MRI score defines

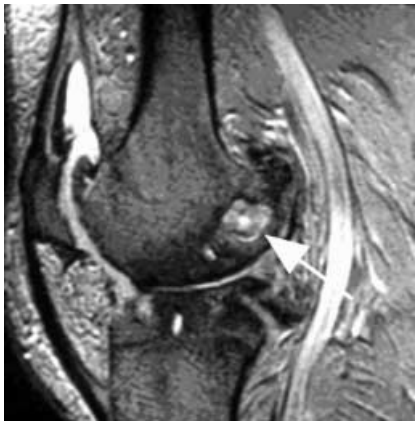

Fig. 7. Sometimes a subchondral cyst may have synovium within it, causing the intermediate signal on this sagittal gradient echo image of the knee (arrow).

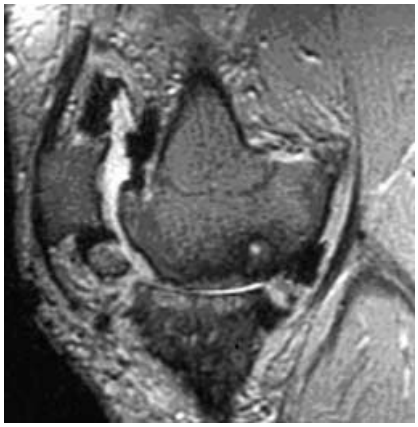

Fig. 8. Articular cartilage loss in an older child is easy to delineate on gradient echo imaging, as on this coronal image of the ankle.

'cartilage loss' as less than 50% loss of the expected height of the joint space on a coronal image of the joint for a moderate change and 50% or greater loss for a severe change [23].

In what clinical situations is MRI useful or necessary?

Before the development of clinically evident arthropathy, MRI findings can be used to select patients for early prophylaxis. This is especially helpful as part of a research study to compare various early treatment regimens [26]. Later in the development of the disease MRI can confirm the presence of synovitis and distinguish bleeding that is either inside or outside the joint. If arthropathy has developed to the stage where surgical intervention is being considered, MRI can confirm the severity of the synovitis or help in the decision to employ radiosynoviorthesis, although one study questioned the value of this evaluation [23]. Prior to surgery, some insurance plans require MRI or arthrography to confirm the severity of the disease. In older patients with advanced disease MRI can distinguish hypertrophied synovium from late degenerative changes. As mentioned above, haemosiderin may remain in the damaged joint for a long time, and MRI cannot detect 'activity' of the synovitis. Intravenous gadolinium contrast may aid in this distinction [21].

Problems with the radiographic scoring systems that need to be resolved

Each of the current scoring systems has issues that could be clarified. In the Arnold–Hilgartner scale (Table 1), 'osteoporosis' is a crude measure at best and difficult to quantify. 'Overgrowth of epiphysis' means that the end of the bone is enlarged. It may be difficult to tell this if the other side is not available for comparison. 'Cartilage space narrowed' may be easy to tell in adults, but it is a different situation in children, especially if there are no comparison films. 'Fibrous joint contracture' is more likely part of the physical examination scale rather than X-ray. Enlargement occurs in stage II; what happens in stages III and IV, prior to the enlargement described as stage V?

Additional Pettersson terms, not in the Arnold–Hilgartner scheme, could be defined further (Table 2). 'Irregular subchondral surface' is defined as 'partly involved' or 'totally involved'. Does this mean that the cartilage has been eroded and the joint space narrowed? Do 'erosions' of the articular surface produce this 'irregular' surface? 'Narrowing of joint space' uses the terms 'greater than' or 'less than 1 mm'. These numbers would not apply in a young child. 'Subchondral cyst formation' may be difficult to separate from erosions. If there are multiple small cysts along the articular surface, some with large openings on the articular surface, how do we decide whether to call these cysts or erosions? Are we scoring the same phenomenon twice? 'Erosions at joint margins' presumably refers to the 'medial' and 'lateral' edges of a joint, ie the bare areas. Do 'partial' and 'full surface' erosions refer to cartilage loss in a horizontal or a vertical direction? If the cartilage is worn away completely along the margin of a joint, is this erosion in addition to cartilage loss? 'Gross incongruence of articulating bone ends' can be slight or pronounced. How can something gross also be slight? Does 'incongruence' mean translation or subsidence of one of the articular surfaces relative

to the other or something else? 'Joint deformity (angulation and/or displacement between articulating bones)' sounds the same as gross incongruence.

Problems with the MRI scoring system that need to be resolved

The Denver MRI scale will also benefit from further clarification. 'Effusion' and 'synovial hyperplasia' are critical MRI findings (Table 3). Can we quantify them more precisely? Is it important to distinguish 'haemarthrosis' from 'effusion'? Should haemosiderin deposition be counted as a finding separate from synovial hyperplasia? Cartilage loss is easy to detect in adults; in young children, it may be difficult to tell articular cartilage and immature growth cartilage apart. Extraneous findings, such as pseudotumour, osteonecrosis, ligament tear and loose bodies are recorded, but are not used as part of the joint score (Table 3). Should they be included in the score?

Conclusion

MRI will play an important role in staging patients for appropriate treatment of haemophilic joint disease. There is need for a consensus on how these joints should be imaged and how they should be scored so that the results of treatment regimens can be compared between various medical centres. Better ways to quantify the degree of abnormality will be useful.

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References

1 Walsh CE. Gene therapy for the hemophilias. *Curr Opin Pediatr* 2002; **14**: 12–6.
2 Nuss R. Controversies in prophylactic therapy. In: McArthur James R, ed. *Pediatric Issues in Hemophilia. (Am Soc Hematol Educ Program)*. Washington D.C.: American Society of Hematology 1997, 48–54.
3 Fischer K, van der Bom JG, Mauser-Bunschoten EP *et al.* The effects of postponing prophylactic treatment on long-term outcome in patients with severe hemophilia. *Blood* 2002; **99**: 2337–41.
4 Roosendaal G, van den Berg HM, Lafeber FP, Bijlsma J. Pathology of synovitis and hemophilic arthropathy. *Orthopäde* 1999; **28**: 323–8.
5 Nagele M, Kunze V, Hamann M *et al.* Hemophiliac arthropathy of the knee joint. Gd-DTPA-enhanced MRI; clinical and roentgenological correlation. *Rofo Fortschr Gebroentgenstr Neuen Bildgeb Verfahr* 1994; **160**: 154–8.
6 Thomason HC, Wilson FC, Lachiewicz PF, Kelley SS. Knee arthroplasty in hemophilic arthropathy. *Clin Orthop* 1999; **360**: 169–73.
7 Nuss R, Kilcoyne RF, Rivard GE, Murphy J. Late clinical, plain x-ray and magnetic resonance imaging findings in haemophilic joints treated with radiosynoviorthesis. *Haemophilia* 2000; **6**: 658–63.
8 Arnold WD, Hilgartner MW. Hemophilic arthropathy. Current concepts of pathogenesis and management. *J Bone Joint Surg* 1977; **59A**: 287–305.
9 Pettersson H, Ahlberg A, Nilsson IM. A radiologic classification of hemophilic arthropathy. *Clin Orthop* 1980; **149**: 153–9.
10 Greene WB, Yankaskas BC, Guilford WB. Roentgenographic classifications of hemophilic arthopathy. Comparison of three systems and correlation with clinical parameters. *J Bone Joint Surg* 1989; **71A**: 237–44.
11 Bender JM, Unalan M, Balon HR, Nagle CE. Hemophiliac arthropathy. Appearance on bone scintigraphy. *Clin Nucl Med* 1994; **19**: 465–6.
12 Forbes CD, Greig WR, Prentice CR, McNicol GP. Radioisotope knee joint scans in haemophilia and Christmas disease. *J Bone Joint Surg* 1972; **54B**: 468–75.
13 Gallacher SJ, Deighan C, Wallace AM *et al.* Association of severe haemophilia A with osteoporosis: a densitometric and biochemical study. *Q J Med* 1994; **87**: 181–6.
14 Chhem RK, Beauregard G. Synovial diseases. *Clin Diagn Ultrasound* 1995; **30**: 43–57.
15 Walther M, Harms H, Krenn V, Radke S, Kirschner S, Gohlke F. Synovial tissue of the hip at power Doppler US. Correlation between vascularity and power Doppler US signal. *Radiology* 2002; **225**: 225–31.
16 Jacobson JA, Lax MJ. Musculoskeletal sonography of the postoperative orthopedic patient. *Semin Musculoskeletal Radiol* 2002; **6**: 67–77.
17 Hermann G, Gilbert MS, Abdelwahab IF. Hemophilia. Evaluation of musculoskeletal involvement with CT, sonography and MR imaging. *AJR* 1992; **158**: 119–23.
18 Funk MB, Schmidt H, Keruz W. Evaluation of haemophilic arthropathy – a comparison of MRI and Pettersson score. *Rofo Fortschr Geb Röntgenstr Neuen Bildgeb Verfahr* 2002; **174**: 314–20.
19 Nuss R, Kilcoyne RF, Geraghty S, Wiedel J, Manco-Johnson M. Utility of magnetic resonance imaging for management of hemophilic arthropathy in children. *J Pediatr* 1993; **123**: 388–92.
20 Bush CH. The magnetic resonance imaging of musculoskeletal hemorrhage. *Skeletal Radiol* 2000; **29**: 1–9.
21 Rand T, Trattnig S, Male C *et al.* Magnetic resonance imaging in hemophilic children: Value of gradient echo

and contrast-enhanced imaging. *Magn Reson Imaging* 1999; **17**: 199–205.
22 Clunie GPR, Wilkinson ID, Lui D *et al.* Changes in articular synovial lining volume measured by magnetic resonance in a randomized, double-blind, controlled trial of intra-articular Samarium-153 particulate hydroxyapatite for chronic knee synovitis. *Rheumatology (Oxford)* 1999; **38**: 113–7.
23 Nuss R, Kilcoyne RF, Geraghty S *et al.* MRI findings in haemophilic joints treated with radiosynoviorthesis with development of an MRI scale of joint damage. *Haemophilia* 2000; **6**: 162–9.
24 Lynch JA, Zaim S, Zhao J *et al.* Automating measurement of subtle changes in articular cartilage from MRI of the knee by combining 3D image registration and segmentation. In: M Sonka, KM Hanson, editors. *Proceedings of the SPIE. Medical Imaging*, Bellingham, WA, USA: International Society for Optical Engineering 2001: 431–9.
25 Dardzinski BJ, Laor T, Schmithorst VJ, Klosterman L, Graham TB. Mapping T2 relaxation time in the pediatric knee: Feasibility with a clinical 1.5-T MR imaging system. *Radiology* 2002; **225**: 233–9.
26 Nilsson IM, Berntorp E, Lofqvist T, Pettersson H. Twenty years' experience of prophylactic treatment in severe haemophilia A and B. *J Intern Med* 1992; **232**: 25–32.

Open discussion following the presentation by Dr Ray Kilcoyne

Dr Carlos Rodriguez-Merchan: Have you made any comparison study between the radiological classification system of Pettersson and your magnetic resonance imaging (MRI) classification?

Dr Kilcoyne: In terms of sensitivity, we know that MRI is much more sensitive because we are looking at soft tissue changes, which are excluded in the Pettersson scale, so in that regard they are different. For more advanced disease with bone changes, many times you can see the cysts equally well on plain films, and I think sometimes you can see the erosions better. I don't have a statistical study to show that MRI is better, but with the advanced bone changes, sometimes the X-ray is better than MRI.

Dr Marilyn Manco-Johnson: You allude to the fact that osteoporosis may not be an important finding. Do you think that for the purpose of preventing arthropathy, we should be interested in anything other than cysts, erosions and cartilage narrowing?

Dr Kilcoyne: Based on my experience with imaging rheumatoid arthritis, I don't know that finding early bone changes that are easily reversible on X-ray really has any meaning in terms of predicting who is going to progress. But I think that finding synovitis and joint effusion and knowing why the joint is boggy on physical exam can also be useful.

Dr Marilyn Manco-Johnson: Do you think that ultrasound would help in looking at synovitis?

Dr Michael Manco-Johnson: You may be able to measure the quantity of synovium much better with ultrasound than you can with MRI. But it is also more confusing, because it is a technically difficult exam.

Dr Rolf Ljung: The proposed Denver score has been tested on a small scale in our paediatric network, and one of the ideas they had with that score was to separate irreversible from reversible changes, and perhaps use the score for reversible changes to optimize treatment. In terms of additive or progressive scales, it could be sometimes one is more useful than the other, depending on what you're going to use the score for.

Dr Kilcoyne: I would agree with that. The reversible changes would be joint effusion and synovial proliferation.

Dr Marilyn Manco-Johnson: We don't know yet whether synovial hyperplasia is reversible or not.

Dr Victor Blanchette: When you look at young boys with severe haemophilia whose joints you have studied where there has not been a reported history of a bleed, how many times do you see abnormalities on MRI, and what are the abnormalities that you do see?

Dr Kilcoyne: These children we are imaging are in the prophylaxis study, and I am blinded to their history. Many children have completely normal joints before the age of 2 years. In some we might see a small effusion or a tiny bit of synovium where I might equivocate and say I'm not sure if that is synovium. But I can't put that into a clinical context, because I don't have the information.

Dr Marilyn Manco-Johnson: On the baseline evaluation before the children were randomized, we noted that about 10% of children had a tiny shadow that could have been either fat or a tiny bit of synovium. There was no correlation with the parents' records of possible joint bleeds. We won't know more until they get to be age 6: if it goes away, maybe it was not significant; if it progresses, maybe it was. We are hoping, too, that the joints without clinical bleeds will be normal on the MRI and that will correlate with the physical assessment, so that in the future, we'll be able to say if it looks normal and you have not had a bleed, don't worry about it.

Dr Alessandro Gringeri: In your opinion, will MRI be something useful for clinical trials or also in clinical practice?

Dr Kilcoyne: I think it is an exciting and very useful tool, but I don't want to oversell it. Let's

suppose you have a child who is said to have bleeding in a joint every couple of weeks and is getting replacement factor, and you don't think that is the correct diagnosis, MRI is certainly the best way to show whether there is fluid or synovium in the joint. I think it would be used to investigate the problem cases in clinical practice, the patients who are not responding, or the ones who are difficult to diagnose.

Dr Marilyn Manco-Johnson: In terms of clinical use, if we have a plan to start prophylaxis with the first joint bleed, sometimes it helps convince the parent if we do the MRI and see if it's fluid, and maybe an ultrasound would work there, too. If an adult is using a lot of factor and we think it's for arthritic pain, we get the MRI and show them that there's no haemosiderin, so there can't have been blood. In patients with inhibitors, we do it frequently. If we can't control the bleeding perfectly, we will get it to detect synovial hyperplasia and do a (32)P injection earlier rather than later to try to prevent progression of the joint disease.