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The Rheumatoid Knee before and after Arthrocentesis and Prednisolone Injection: Evaluation by Gd-Enhanced MRI

R. LEITCH*, S. E. WALKER*,***, A. E. HILLARD**

Summary **In patients with rheumatoid arthritis, intraarticular injection of corticosteroids is an accepted means of treating a symptomatic joint. It has previously been impossible to precisely quantitate the effects of these injections on synovial effusion and pannus. Magnetic resonance imaging (MRI) is a safe, effective means of evaluating joint anatomy, and the use of intravenous gadolinium (Gd)-containing contrast allows clear differentiation of fluid from abnormal synovial tissue. The current study utilized MRI with Gd-labeled diethylene-triamene pentacetic acid (Gd-DTPA) contrast to evaluate serial changes in 6 knees of 6 patients with rheumatoid arthritis, following arthrocentesis and intraarticular injection of prednisolone. One week after the corticosteroid was injected, 2 patients had reduction of pannus width to 20% and 68% of baseline measurements. In these same individuals, follow-up sagittal views showed decreases of total effusion and fluid-plus-pannus width. The other 4 patients, who were followed for 4 weeks, had minimal changes in fluid and synovium. Gd-DTPA-enhanced MRI permits precise assessment of effects of intraarticular injections on synovial fluid and pannus in the rheumatoid knee.**

Key words **Knee, Rheumatoid Arthritis, Magnetic Resonance Imaging, Gadolinium-DTPA, Prednisolone.**

INTRODUCTION

Intraarticular injection of a corticosteroid preparation is used widely to treat painful, swollen joints in patients with rheumatoid arthritis (1). This therapy is thought to be particularly beneficial for patients with relatively inactive disease, who have 1 or 2 symptomatic joints (2). The improvement in swelling and tenderness that often occurs after articular injection is attributed to the potent anti-inflammatory effects of corticosteroids. Improvement is usually apparent by clinical examination, but the clinician cannot accurately differentiate swollen pannus from excessive synovial fluid (3).

A reliable, noninvasive means of evaluating responses to anti-inflammatory therapy is needed to permit accurate and objective evaluation and comparison of intraarticular treatment. Conventional radiography is not suitable, as radiographs mainly detect cartilage loss and destructive bone changes. Computed tomography is useful in evaluating osseous regions with complex anatomy, but offers little advantage in visualization of intraarticular structures (4). Recently, sonography was applied to estimate the size of effusion and synovial thickness in the suprapatellar pouch. Twenty patients with rheumatoid arthritis were tested before injection of a corticosteroid preparation, and 10 and 30 days after injection. Measurements were reproducible, but there was difficulty in quantitating nodular pannus and floating hyperechoic material (5).

Magnetic resonance imaging (MRI) is a safe, noninvasive method of evaluating the detailed anatomy of diarthrodial joints and associated soft tissues (4). This method has recently been applied to delineate abnormalities of the knee in rheumatoid arthritis. Unenhanced MRI studies will reveal abnormal intraarticular collections of fluid, as well as previously unsuspected cartilage damage and cyst formation (6). The use of intravenous gadolinium (Gd)-containing contrast adds to the specificity of MRI by clearly differentiating joint effusion from ab-

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normal synovial tissue (6), and this method has the potential to reveal intraarticular changes after treatment. In an earlier report, 3 patients with rheumatoid arthritis were examined with MRI and Gd-labeled diethylenetriamene pentacetic acid (Gd-DTPA) contrast. Imaging studies were performed before and after arthrocentesis and intraarticular administration of steroids (steroid preparation and dose not specified). Joint swelling decreased 1 month after treatment, and both the amount of pannus and the intensity of pannus enhancement were diminished on follow-up images (6).

The current study was designed so that patients with rheumatoid arthritis and a swollen, painful knee could have serial imaging studies to examine the effects of a defined corticosteroid, injected into the joint, on joint effusion and pannus. MRI with intravenous Gd-DTPA contrast was performed before, and at intervals after aspiration of synovial fluid and injection of prednisolone. Fluid volume was estimated, thickness of enhanced synovial tissue was measured, and fluid plus synovial width was measured in 3 sites to determine if local exposure to a corticosteroid preparation would produce visible and lasting reduction of either rheumatoid effusion, pannus, or both components in the knee.

PATIENTS AND METHODS

Patients

Six men with rheumatoid arthritis were recruited from the clinics of the Harry S. Truman Memorial Veterans' Hospital and the University of Missouri Health Sciences Center between June 1993 and June 1994. Each subject had a painful swollen knee that interfered with ambulation, and gave informed consent for study under a protocol approved by the Investigational Review Board of the University of Missouri Health Sciences Center. Patients were aged (mean ± SEM) 49 years ± 4 (range 36 to 61 years), and duration of disease was 9 years ± 3 (range 2 to 16 years). All patients met the American Rheumatism Association criteria for classification of rheumatoid arthritis (7) and had positive tests for rheumatoid factor. The patients were maintained on longterm treatment with nonsteroidal anti-inflammatory drugs, and patient # 3 took a stable dose of prednisone, 15 mg/day. Patient # 2 started treatment with cyclosporine A, 200 mg/day, 1 week before entry and patient # 4 started methotrexate, 7.5 mg orally once weekly, 1 day after entry. The other 4 patients received chronic therapy with long-acting disease modifying agents for at least 1 month before entry, and during the 4-week period after arthrocentesis.

Magnetic Resonance Imaging

MRI with the knee in a neutral position was performed on a 1.5-T Helicon magnet (Magnetom, Siemens Medical Systems, Erlangen, Germany) equipped with a dedicated knee coil capable of transmitting and receiving. A T1 weighted spin-echo axial scan (TR/TE 200/15, 10-mm sections) was done for localization. This was followed by 4-mm thick T1-weighted sagittal and coronal (TR/TE 810/15, 2 acquisitions) spin-echo sequences and 4-mm spin-echo T2-weighted sagittal (TR/TE 2900/90, 1 acquisition) images. Four patients also had sagittal and coronal (TR/TE 550/10, 70° flip angle, 2 acquisitions) gradient refocused echo sequential 2 dimensional Fourier transform fast low-angle show (FLASH) imaging, with 4-mm contiguous sections. The field of view for all sequences was 20 cm, with a 256 × 256 matrix.

Gd-DTPA (Magnevist, provided through the courtesy of Berlex Laboratories, Wayne, NJ) was then given intravenously, in a dosage of 0.1 mmol/kg of body weight. Within 25 seconds, sequential FLASH imaging was repeated according to the protocol used before Gd-DTPA was injected. Following this sequence, post-contrast T1 weighted imaging was performed as described above.

Arthrocentesis Protocol

The study knee was entered from the medial aspect with a 20-gauge needle under sterile conditions and the largest possible volume of synovial fluid was evacuated. The needle was left in place, sterile prednisolone sodium succinate (Hydeltrasol; Merck Sharp & Dohme, Division of Merck & Co., West Point, PA) was injected, and the needle was withdrawn immediately. Patients #1 and #3 received 30 mg of intraarticular prednisolone, and the other 4 patients received 20 mg doses. Ambulation was permitted after the procedure.

Aspiration and injection took place within 24 hours after the baseline scan (N = 5) or 1 week later (N = 1). The injected knees were scanned 1 week (N = 5), and 4 weeks (N = 4) after aspiration and steroid injection.

Grading MR Images

A radiologist who did not know the clinical status of the patients performed the following measurements after the scans were completed.

1) *Synovial effusion:* The amount of synovial effusion was estimated in sagittal and coronal views, and graded 0 to 4+ according to this scale: 0 = normal; 1+ = volume greater than normal, no extension into suprap-

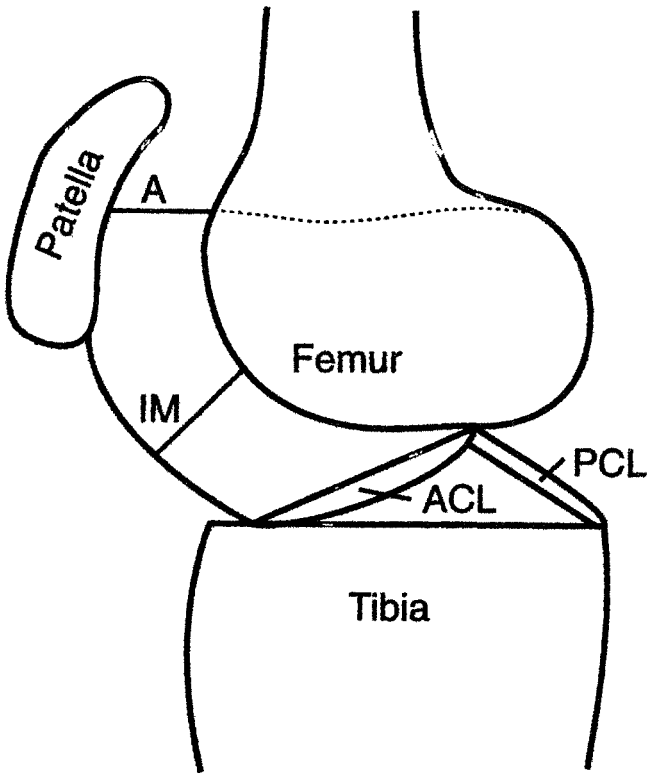

Fig. 1: Widths which included synovial tissue and synovial fluid were measured in a sagittal view of the knee showing the anterior cruciate ligament (ACL), and in a separate sagittal view showing the posterior cruciate ligament (PCL). In the ACL and PCL views, measurements were taken along a horizontal line (A) extending from the closed femoral subepiphyseal (growth) plate at the outer edge of the cortex, to the patella. Synovium plus fluid was also measured at the infrapatellar margin along a imaginary line perpendicular to the femoral surface (IM). The line began at a point located midway between the patella and the anterior superior lip of the tibia, and extended to the articular border of Hoffa's fat pad.

atellar space; 2+ = volume greater than normal, minimal extension into suprapatellar space; 3+ = volume greater than normal, definite extension into suprapatellar space, no joint distention; 4+ = volume greater than normal, extension into suprapatellar space, joint distention present.

2) *Synovial thickness:* Thickness of synovium was measured post-Gd-DTPA, in comparable coronal views.
3) *Measurements of width of effusion plus synovium:*
   a) Anterior cruciate ligament (ACL) measurement: The distance was measured between the outer cortex of the distal femur and the patella, in one sagittal view showing the ACL.
   b) Posterior cruciate ligament (PCL) measurement: The distance was measured between the outer cortex of the distal femur and the patella, in one sagittal view showing the PCL. The ACL and PCL measurements were taken along a horizontal line passing through the closed femoral subepiphyseal (growth) plate and extending to the patella (Fig. 1).
   c) Infrapatellar margin (IM) measurement: The IM measurement was taken in one sagittal view that included the maximum anterior-posterior diameter of the patella. The IM measurement extended from the anterior femoral condyle, at a point located midway between the patella and the anterior superior lip of the tibia, to the articular border of Hoffa's fat pad (Fig. 1).

Table I: *Serial enhanced MRI grading of synovial fluid and measurements of synovial thickness*

	Synovial Effusion* (0-4+)			Synovial thickness† (mm)		
Patient	0	1 wks	4**	0	1 wks	4**
1	4+	3+	ND	22	15	ND
2	2+	1+	ND	10	2	ND
3	4+	ND	2+	4	ND	4
4	4+	3+	3+	4	3	3
5	2+	2+	2+	4	2	3
6	3+	3+	3+	4	4	4

* The amount of synovial fluid in the knee was estimated in sagittal and coronal views, and graded as 0 = normal; 1+ = volume greater than normal, no extension into suprapatellar space; 2+ = volume greater than normal, minimal extension into suprapatellar space; 3+ = volume greater than normal, definite extension into suprapatellar space, no joint distention; 4+ = volume greater than normal, extension into suprapatellar space, joint distention present.

† Thickness of synovial tissue was measured in mm on comparable enhanced coronal sections.

** 0 = preinjection, 1 = 1 wk after prednisolone injection, 4 = 4 wks after prednisolone injection.

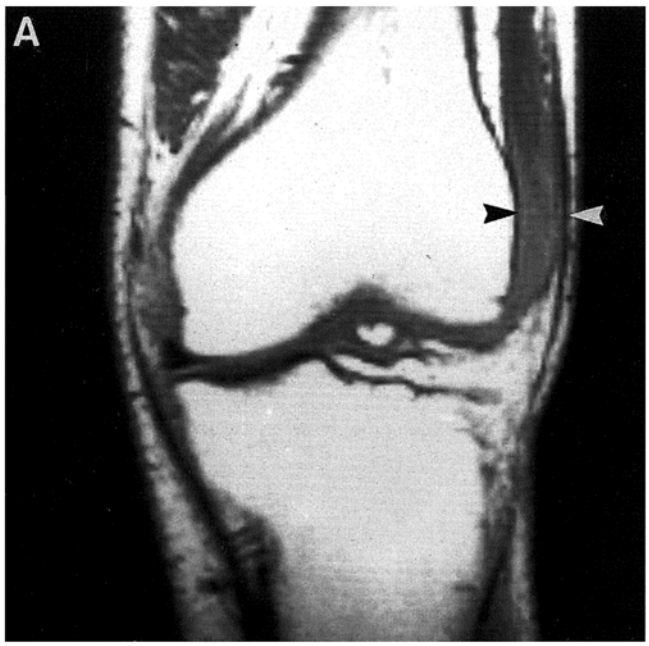

Fig. 2A: Baseline pretreatment coronal T1-weighted image in patient #2, no contrast. In this nonenhanced image, synovial effusion is not separated from synovium in the space between the arrows.

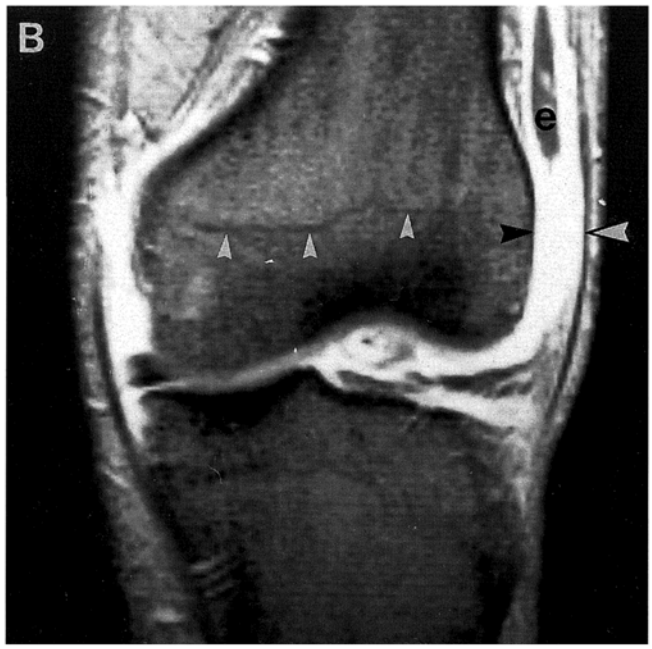

Fig. 2B: This pretreatment FLASH image in patient # 2 corresponds to the area in Figure 2A. The use of Gd-DTPA contrast allows synovium to be visualized as white, and fluid as gray. The fused epiphyseal plate is a dark horizontal line (small arrows). The thick, hyperintense synovium (between large arrows) is differentiated clearly from the synovial effusion (e).

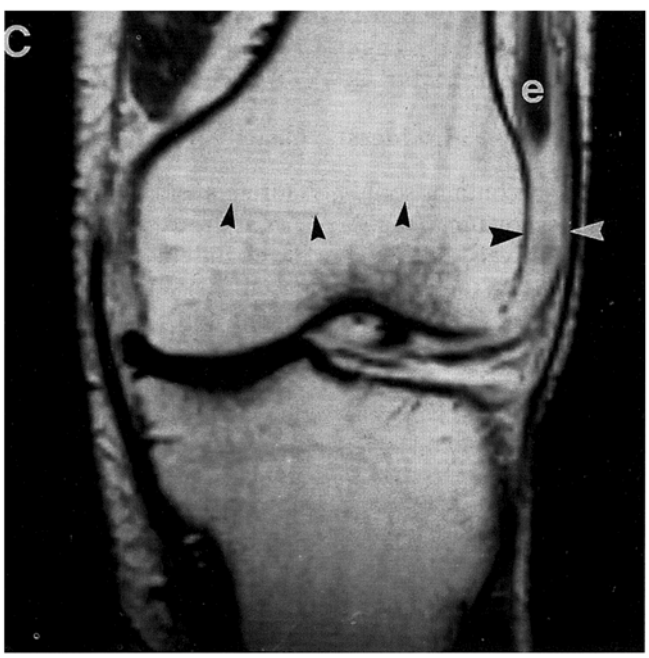

Fig. 2C: T1-weighted image, following Gd-DTPA, before injection of prednisolone into the left knee of patient #2. The use of contrast allows clear definition of the 10 mm-thick synovium (large arrows) at the level of the fused epiphyseal plate (small arrows) in this coronal section. The white pannus is demarcated clearly from the black synovial effusion (e).

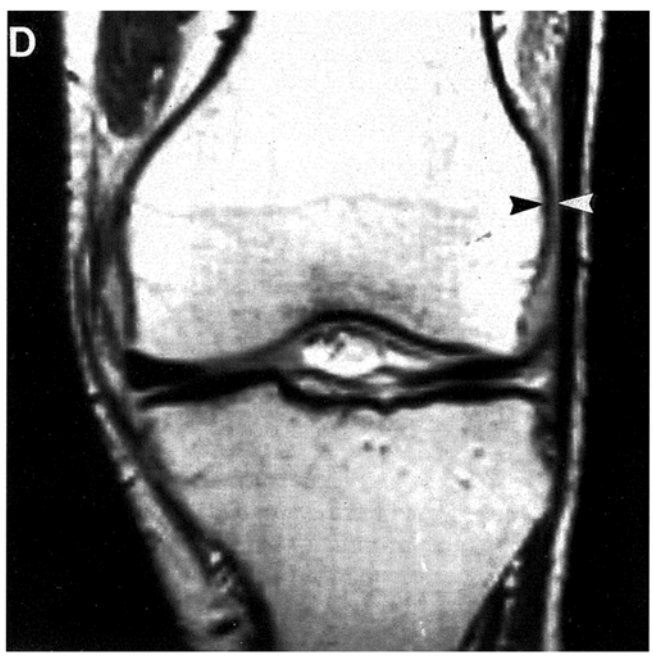

Fig. 2D: T1-weighted image with Gd-DTPA contrast, taken 1 week after joint aspiration and intraarticular injection of prednisolone in the same patient (#2). Synovium, indicated by arrows, is 2 mm thick at the level of the fused epiphysial plate.

Table II: *Serial widths of synovial fluid plus synovium in enhanced sagittal MRI views at 3 fixed sites*[*]

	ACL Measurement (mm)			PCL Measurement (mm)			IM Measurement (mm)		
Patient	0	1 wks	4†	0	1 wks	4†	0	1 wks	4†
1	10	6	ND	18	16	ND	12	10	ND
2	10	5	ND	10	9	ND	5	4	ND
3	21	ND	10	10	ND	10	6	ND	6
4	11	11	9	18	15	15	8	8	10
5	5	4	5	11	10	11	4	4	3
6	9	9	9	9	9	7	7	6	4

[*] The widths of synovial fluid plus synovial tissue were evaluated serially at 3 designated locations, on sagittal views of the knee. The anterior cruciate ligement (ACL) and posterior cruciate ligament (PCL) were constant markers for the levels at which the ACL and PCL measurements were made, and the infrapatellar margin (IM) measurement was made at a defined point between the anterior femoral condyle and the patella (Figure 1).

† 0 = preinjection, 1 = 1 wk after prednisolone injection, 4 = 4 wks after prednisolone injection.

RESULTS

Clinical Evaluation

At entry, all 6 patients gave a history of pain in the study knee and each knee was swollen by physical examination. Knee pain was decreased in all patients following arthrocentesis and prednisolone injection, and 5 patients had some reduction of swelling in the treated knee by clinical assessment. Knee size was judged to be unchanged after arthrocentesis and injection in patient #6.

Assessment of Knee Effusions

Table I lists assessments of knee effusion size, before and after intraarticular treatment, based upon Gd-DTPA-enhanced sagittal and coronal views. The initial estimates were (range) 2+ to 4+, and posttreatment MRI showed some reduction of fluid at follow-up in 4 patients. Effusions were unchanged in patients #5 and #6.

Measurement of Synovium

Table I also records thickness of synovial tissue. Patients #1 and #2, who were evaluated 1 week after treatment, had the most prominent pannus formation at entry with Gd contrast-enhanced synovium that measured 22 mm and 10 mm thick, respectively. One week after intraarticular prednisolone, there was striking reduction of pannus to 68% and 20% of the baseline measurements. Patient #5 had reduction of less prominent synovial thickness, from 4 mm to 2 mm, 1 week after treatment. Results of the 4-week follow-up evaluations showed persistent 1 mm reductions in synovial width in 2 individuals (patients #4 and #5), and patients #3 and #6 were unchanged.

Coronal views allowed consistent visualization of synovium in the frontal plane and were used for measuring synovial thickness. Figure 2A shows the failure to differentiate fluid from pannus in MRI without contrast in the left knee of 2 patient # 2. Figures 2B and 2C display pretreatment pannus formation (10 mm thick), which is differentiated from synovial effusion in the enhanced coronal images. One week after intraarticular prednisolone, synovium in a comparable follow-up image measured 2 mm thick (Fig. 2D).

ACL, PCL, and IM Measurements

Table II contains serial measurements of synovial fluid plus synovium in sagittal views at the designated ACL and PCL levels, and at the IM level. Baseline values were (range) 5 mm to 21 mm for the ACL measurement, 9 mm to 18 mm for the PCL measurement, and 4 mm to 12 mm for the IM measurement.

Treatment was followed by reductions of at least 1 of these parameters in every patient. The most notable improvements were observed in the ACL measurement. Patients #1 and #2 had remarkable decreases in this width 1 week after treatment. The fluid-plus-pannus measurements were reduced to 60% and 50% of the original values, respectively, after intraarticular injection of prednisolone. Patient #3 had notable improvement in the ACL measurement after 4 weeks of follow-up (52% reduction compared to the initial value), but the PCL and IM were the same.

Patients #4, #5, and #6 had minimal improvement in serial sagittal views (Table II). In these individuals, a total of 18 ACL, PCL, and IM measurements were tak-

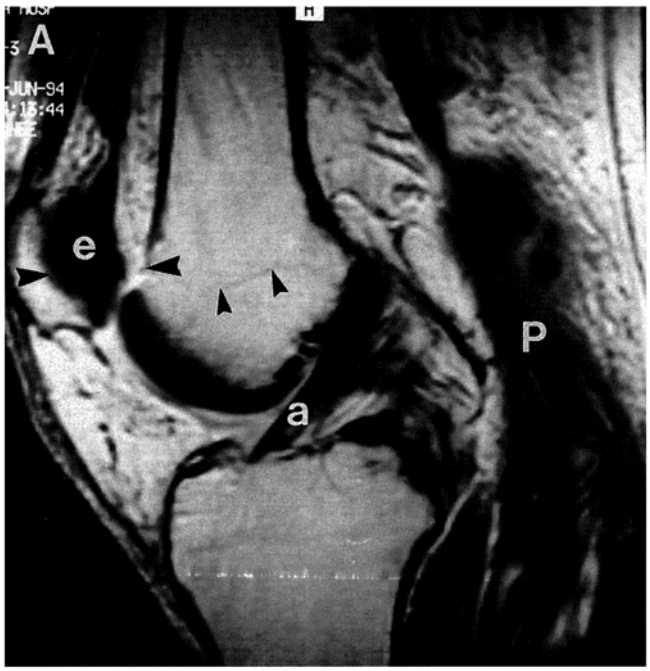

Fig. 3A: ACL measurement, T1-weighted sagittal image of the right knee of patient #3, following intravenous Gd-DTPA. This baseline examination shows a 4+ effusion (e) extending into the suprapatellar space, with a 21-mm measurement (large arrows) taken between the outer edge of bone at the growth plate (small arrows) and the patellar margin at the level of the ACL (a). A large popliteal cyst (P) is visualized.

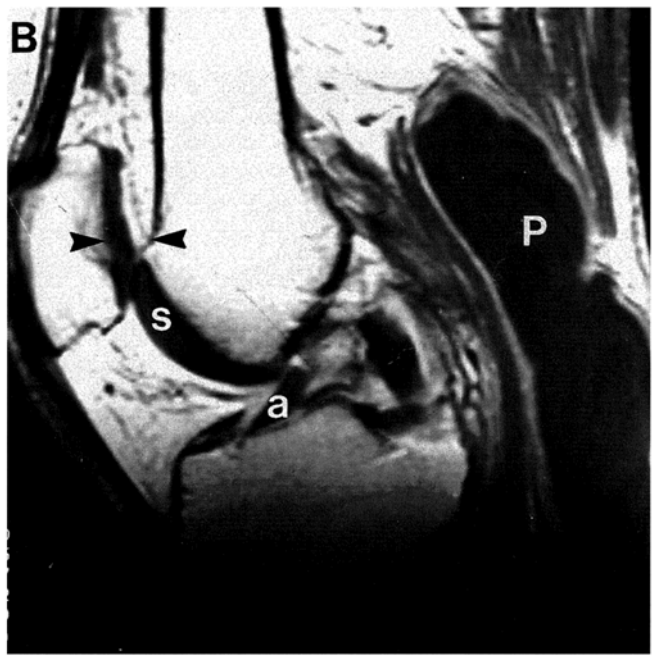

Fig. 3B: Follow-up ACL measurement, patient #3, T1-weighted sagittal image with Gd-DTPA corresponding to Figure 3A. Four weeks after the right knee was aspirated and injected with 30 mg of prednisolone sodium succinate, the effusion in the suprapatellar pouch has resolved. Width (between arrows) at the ACL (a) is 10 mm. Synovium (s) images dark grey. This faint enhancement suggests that the tissue is primarily fibrotic and not inflamed. The patella moved medially after the effusion disappeared, and it is more clearly seen in this view.

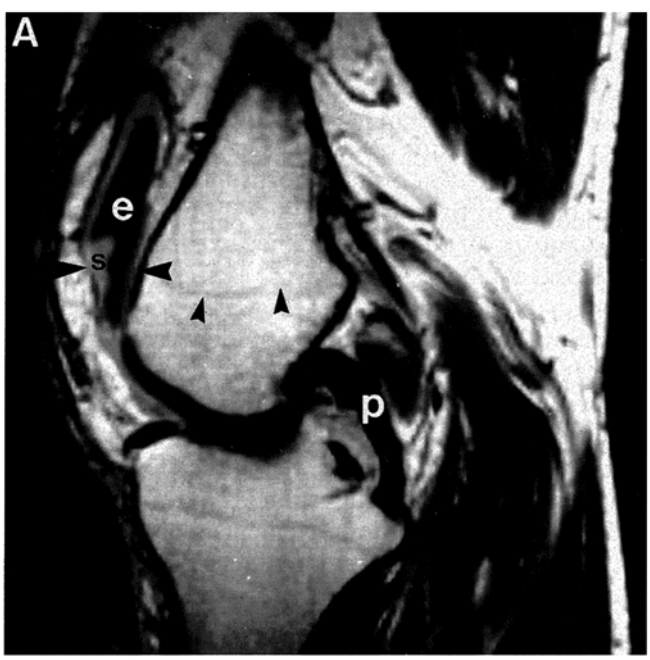

Fig. 4A: PCL measurement, T1-weighted sagittal image, post-Gd-DTPA, patient #2. The left knee, imaged before aspiration and prednisolone injection, contains nodular, thick synovium (s) that enhances strongly and a 2+ synovial effusion (e); both measure 10 mm (large arrows) at the level of the PCL (P). The measurement was taken along a horizontal line between the growth plate (small arrows) and the patellar margin. Note that the measurement does not include the bony cortex, which images blac.

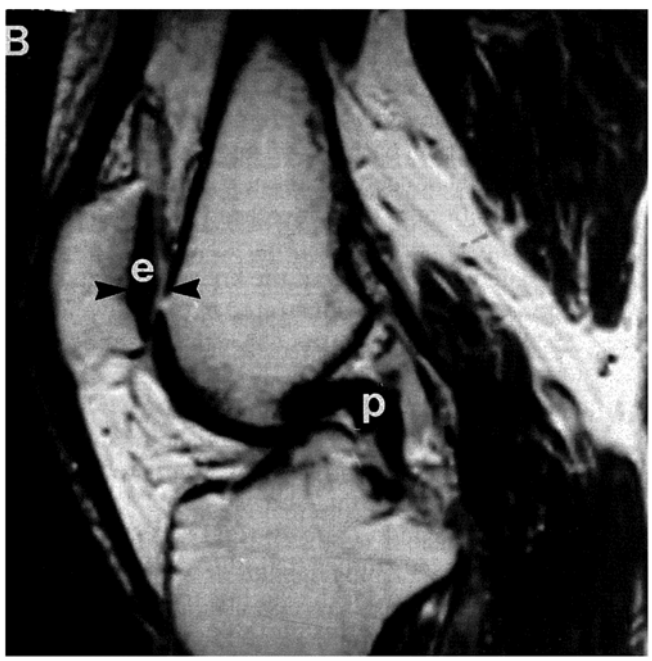

Fig. 4B: Follow-up PCL measurement, patient #2, T1-weighted sagittal image after Gd-DTPA. One week after the left knee was aspirated and injected with 20 mg of prednisolone, the measurement (between arrows) was 9 mm. Nodular synovial tissue is not visualized in this post-treatment image. The patella is better seen, as it has moved medially after the effusion decreased.

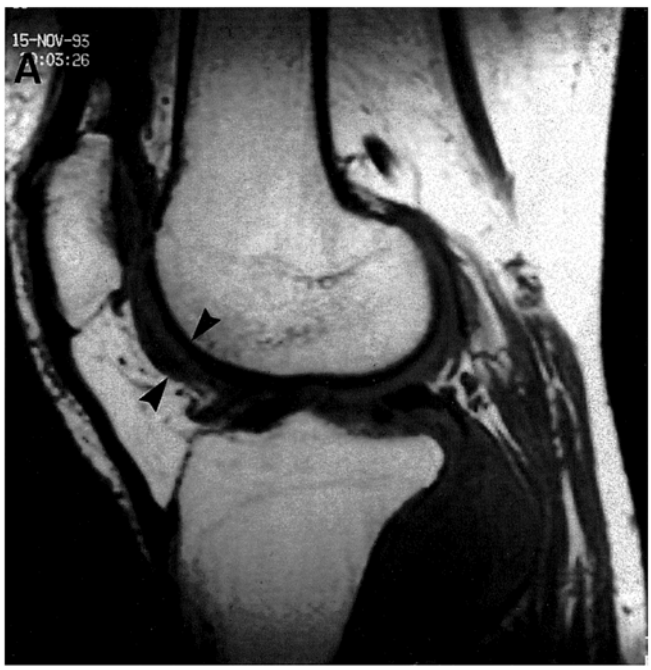

Fig. 5A: IM measurement, T1-weighted sagittal image without contrast, patient #6. Synovial tissue and fluid occupied a 7-mm space (arrows) in a designated measurement taken between the femur and Hoffa's fat pad at the level of the maximum width of the patella (see Methods). The mass posterior to the tibial plateau represents a popliteal cyst.

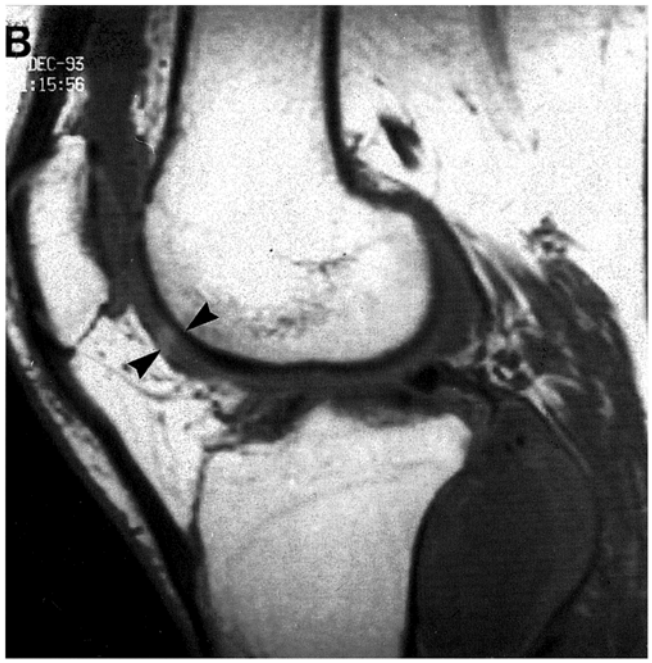

Fig. 5B: IM measurement, T1-weighted sagittal image, no contrast, patient # 6 4 weeks after intraarticular injection of prednisolone. The synovial tissue-synovial fluid IM width (arrows) was 4 mm. The popliteal cyst is unchanged.

en 1 week and 4 weeks postinjection. Nine of these 18 serial measurements were minimally smaller (1 to 3 mm decreases) than the respective baseline values. Four weeks after treatment, the ACL measurement was not changed compared to entry in patients #5 and #6, the PCL measurement was unchanged in patient #5, and the IM measurement in patient #4 was increased from 8 mm to 10 mm.

The detailed morphology of the knee, visualized with intravenous Gd-DTPA, is illustrated in the T1-weighted image in Figure 3A. In patient #3, the baseline ACL measurement reflected mainly the large knee effusion. Four weeks after knee aspiration and intraarticular injection, the fluid collection was diminished (Fig. 3B).

Additional measurements were taken in Gd-DTPA-enhanced sagittal views that showed either the PCL or the IM. Figure 4A and Figure 4B (PCL: patient #2) are sequential enhanced studies that illustrate both apparent resolution of synovial thickening and modest diminution of suprapatellar effusion 1 week after treatment. The baseline IM measurement is illustrated in sagittal images, without contrast, in patient #6. Figure 5A illustrates the 7-mm IM width. Four weeks after prednisolone was injected, the IM measurement in the treated knee was 4 mm (Fig. 5B).

DISCUSSION

The intraarticular use of corticosteroids is an accepted means of achieving palliation in the management of rheumatoid arthritis (7). Studies have shown that a single direct injection of hydrocortisone acetate, its analogs, or the tertiary butyracetate (TBA) ester results in moderate or marked relief of knee swelling, tenderness, and local pain in 65% to 84% of cases (2,8,9). Improvement in the rheumatoid knee, however, is almost always transient. In the initial clinical studies, hydrocortisone TBA and prednisolone TBA preparations provided relief that lasted 1 to 2 weeks (10). Longer periods of benefit are expected after the use of triamcinolone hexacetonide (10), and in patients who are made non-weight-bearing following knee injection (11).

The mechanism of improvement is not well understood. Duration of contact with the synovium appears to vary with the corticosteroid preparation. Hydrocortisone is cleared from the joint cavity within hours (12), but crystalline TBA preparations have been identified in synovial fluid for as long as 1 month after injection (13). It is thought that corticosteroids enter synovial tissue and stimulate increased production of hyaluronate, leading to increased synovial fluid viscosity (14). Postinjection

decreases in synovial permeability have also been observed in osteoarthritic knees (15). Altered synovial vascular permeability may therefore explain decreased plasma filtration and formation of joint fluid after intraarticular steroid treatment. This theory was supported by a study in which injection of corticosteroids was followed by a decreased rate of disappearance of intraarticularly administered radioactive xenon (^{133}Xe) in rheumatoid knees (16).

The current study was undertaken to determine if evacuation of synovial fluid followed by a single corticosteroid injection would either reduce effusion size, result in altered appearance of contrast-enhanced synovium, or change both components. It is recognized that the soluble prednisolone compound used in this study has less potential for producing significant clinical effects compared to suspended, relatively insoluble TBA esters (11). Nevertheless, the solution was chosen for these initial studies in order to avoid the possibility of postinjection synovial fluid leukocytosis, which has been reported in patients who received intraarticular prednisolone TBA or triamcinolone hexacetonide (17). In addition, a small percentage of patients who received intraarticular injections with particulate TBA preparations experienced crystalline arthritis induced by the suspended compound (18). Although these paradoxial responses were characteristically transient, such flares would have had the potential to interfere with MRI of post-treatment changes in pannus and synovial effusion.

MRI to evaluate effects of intraarticular prednisolone utilized Gd-DTPA, a complex of a rare earth element (Gd) and a chelating agent (DTPA). Gd shortens T1 relaxation times of hydrogen nuclei, produces increased signal intensity in T1-weighted images, and also shortens T2 relaxation times. Gd-DTPA, an effective contrast enhancer for MRI, has the advantages of low toxicity and rapid renal excretion (19). Intravenous Gd-DTPA has been employed extensively in neuroradiology. It does not cross the intact blood-brain barrier but does accumulate in lesions (inflammation, infarction, neoplasm) in which the barrier is broken (20).

A number of reports have confirmed the usefulness of Gd-DTPA in imaging the musculoskeletal system. The contrast enters inflamed areas soon after injection, and it is cleared slowly compared to normal surrounding tissues. Areas of inflammation enhance rapidly and become white on T1-weighted (shortened T1 relaxation) images (21). These properties have led to the application of Gd-DTPA to MRI of joints affected by rheumatoid arthritis.

Unenhanced MRI is valuable for evaluating internal derangements, but it only grossly defines synovium in the internal anatomy of the joint. T2-weighted studies are useful for detecting joint fluid, which images white, but fluid and synovium have similar signal intensities on both unenhanced T2-weighted and unenhanced T1-weighted images (22). The use of intravenous Gd-DTPA contrast avoids the problem of imaging in which one intraarticular structure cannot be differentiated from another. Enhancement results in an "intravenous magnetic resonance arthrogram" that clearly differentiates hypervascular rheumatoid pannus from joint fluid (23,24).

Optimal results are obtained if imaging is done promptly after the contrast is injected. Maximum enhancement of hypertrophic synovium has been reported to occur 2 to 11 minutes (mean 4 minutes) after bolus injection of Gd-DTPA (25). The low molecular weight of this contrast agent allows it to diffuse readily into joint fluid in a time-dependent manner. If imaging is delayed more than 5 minutes after Gd-DTPA is injected intravenously, this contrast diffuses into synovial fluid. The fluid then begins to enhance and synovial tissue can no longer be outlined clearly (25). In T1-weighted images taken promptly after injection, early enhancement results in high signal intensity of inflamed synovial tissue (white) which contrasts sharply with the nonenhancing low signal intensity synovial fluid (black) (22,23,25). The enhanced FLASH images that were utilized in the current study had a "large" flip angle of 70° with resultant T1-like images. These views permitted a revisit in the field of interest with minimal additional imaging time, to reexamine nonenhancing knee effusions and confirm the configuration of hyperintense synovium (22).

Five of the 6 treated patients in the current series were judged to have clinical signs of reduced swelling of the knee after treatment, but the improvement could not be localized by physical examination to fluid or soft tissue. Gd-DTPA-enhanced MRI provided an objective means of following changes within the joint. In the MR images, patient #1 and patient #2 had the most consistent evidence of improvement after intrasynovial injection. Before treatment, these patients were found to have thick synovium (22 mm and 10 mm on coronal views, respectively). The prominent enhancement of their synovial tissue with Gd-DTPA contrast implied that the tissue was vascular. This inflamed pannus was thought to be especially susceptible to the potent effects of local corticosteroid therapy. One week post-treatment, repeated imaging of the 2 patients showed prominent reductions in thickness of the synovium, with modestly decreased knee effusions.

In the other 4 patients, synovium was measured 4 mm wide at baseline. This relatively thin layer probably represented rheumatoid synovium with few inflammatory changes, or it may have been composed primarily of fibrous tissue. In these joints, treatment induced little reduction of tissue swelling. This possibility was realized

in these 4 patients, who had only 1 to 2 mm or no post-treatment reduction of tissue width. In patient #3, diminution of knee size represented only loss of joint effusion. In this individual, intraarticular prednisolone was followed by reduction in effusion from 4+ to 2+, and by reduction of the fluid component of the ACL measurement (Figs. 3A and 3B).

In summary, the study has confirmed the utility of Gd-contrast-assisted MRI in separating intraarticular fluid from synovial tissue in the rheumatoid knee. Two of our patients had apparent responses of initially thick synovium to joint aspiration and injection. In 4 other patients whose synovial layers were less thick, the widths of synovium were decreased minimally or not at all and knee effusions had varying changes following intraarticular prednisolone. In the future, similar experiments will hopefully be designed to permit utilization of MRI with Gd-DTPA to precisely follow effects of therapy on effusions and key target tissues in rheumatoid joints.

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