

Ultrasonography of the Hip in the Evaluation of Children with Seronegative Juvenile Rheumatoid Arthritis

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ABSTRACT. Objective. To find an objective measure of hip joint effusion with ultrasound (US) in patients with juvenile rheumatoid arthritis (JRA).

Methods. The hip joints of 24 children with JRA were evaluated with US. All patients were negative for rheumatoid factor and antinuclear antibodies. Patients with unilateral or bilateral hip pain, swelling, or limitation of range of motion were included. In each hip, the distance from the femoral neck to joint capsule was measured. Values were compared to measurements in a control group of 24 children with no history of hip joint or rheumatic disease. Statistically significant differences between the 2 groups were analyzed by t test. Two standard deviations above the control group mean was used as the standard for an effusion.

Results. There was a statistically significant difference in US joint space between the children with JRA and the control subjects ($p < 0.001$). The mean in the control group was 0.43 cm and the mean in the JRA group was 0.60 cm. A distance of 0.59 cm from femoral neck to joint capsule was determined to be consistent with an effusion. Using this standard, 71% of the children with JRA had effusion in at least one hip, and 25% had effusion bilaterally. No control subjects had measurements above this level.

Conclusion. Ultrasonography is effective in the evaluation of hip joint involvement in patients with JRA, and may be useful in facilitating the diagnosis, classification, and followup of this illness. (J Rheumatol 2002;29:629–32)

Key Indexing Terms:

JUVENILE RHEUMATOID ARTHRITIS

HIP INVOLVEMENT

ULTRASOUND

The diagnosis of juvenile rheumatoid arthritis (JRA) is one of exclusion. It is made by the presence of joint swelling or limitation of range of motion with heat, pain, or tenderness in one or more joints for 6 weeks' time, in a child less than 16 years of age¹. Joint pain or tenderness alone is not sufficient for the diagnosis, and other etiologies such as trauma, hematologic illnesses, infectious arthritis, and other rheumatic conditions must be ruled out².

There is no single laboratory test that can confirm or exclude the diagnosis of JRA. Erythrocyte sedimentation rate (ESR) is often abnormal, but is nonspecific. The presence of rheumatoid factor (RF) and antinuclear antibodies (ANA) suggests the diagnosis of JRA, but their absence does not rule it out nor is it indicative of disease activity³. Seronegative JRA or seronegative enthesopathy and arthropathy syndrome (SEA) refers to a subgroup of disease

in which the patient is RF and ANA negative through the course of the illness. These children usually respond well to therapy and suffer relatively little joint destruction⁴. The absence of many positive laboratory findings may make the diagnosis more challenging.

The hip joint is often involved in JRA^{5–7}. Unlike other joints commonly affected, such as the knee, the presence of a hip joint effusion is particularly difficult to detect⁸. Guzman, *et al* found that examiners differed in their assessment of the diagnostic criteria for JRA. There was agreement between observers regarding the presence of tenderness, but substantial disagreement on the presence of swelling and limitation of range of motion. There was also wide variation between observers on total joint count, which resulted in differing classifications of disease type⁹.

Ultrasound (US) has been a useful tool in detecting the presence of joint effusion¹⁰. This may be particularly helpful in patients with JRA without laboratory findings and equivocal symptoms¹¹. Since hip effusions are difficult to palpate, an objective means of detection may facilitate the diagnosis of JRA and be useful in assessing followup¹². Our aim was to establish a set of normal values with US in order to determine a specific measurement of hip joint space — a measurement greater than this would indicate the presence of an effusion.

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MATERIALS AND METHODS

Between August 1998 and August 1999, 24 children with seronegative JRA underwent ultrasound evaluation of both hips. Children being followed for JRA at the pediatric orthopedic clinics at Stony Brook University Hospital or Winthrop University Hospital as outpatients who had clinical symptoms of hip joint involvement were recruited for the study. Patients with unilateral or bilateral hip pain, swelling, or limitation of range of motion were included. The diagnosis of JRA was based on the criteria of the American College of Rheumatology¹. Children were found to be negative for RF and ANA at the time of their diagnosis.

A control group of 24 children underwent US evaluation of both hips over the same period of time. These children were being followed at the pediatric orthopedic clinics for other orthopedic conditions. Children with any history of hip joint disease or rheumatologic condition were excluded.

The study protocol was approved by the Institutional Review Board for the university. Informed consent was obtained from the parents of all patients, and assent was obtained from children over 10 years of age.

The control group consisted of 14 girls and 10 boys with a mean age of 10.1 years (range 4.2–15.9). The group with JRA consisted of 13 girls and 11 boys, mean age 10.4 years (range 4.0–15.2). Therapy for those with JRA consisted of nonsteroidal antiinflammatory drugs.

For each child, US was done on the same day as clinical evaluation. The authors performed all sonographic evaluations, using the Aloka SSD-210DXII with a 5 MHz transducer at Stony Brook and the Aloka SSD-500 with a 5 MHz transducer at Winthrop. These were performed with the patient supine on the examination table, with legs extended, and in neutral position. The transducer was coated with ultrasound gel, placed longitudinally on the anterior proximal thigh, and was moved medially and laterally to visualize the femoral shaft. Once the femoral shaft was found, it was followed superiorly until the femoral neck and head and the joint capsule could be identified. Quantitative assessment of fluid in the hip joint was obtained by saving the image on screen, and placing a mark on the anterior aspect femoral neck and on the posterior border of the joint capsule, indicating the greatest distance between the 2 structures (Figure 1).

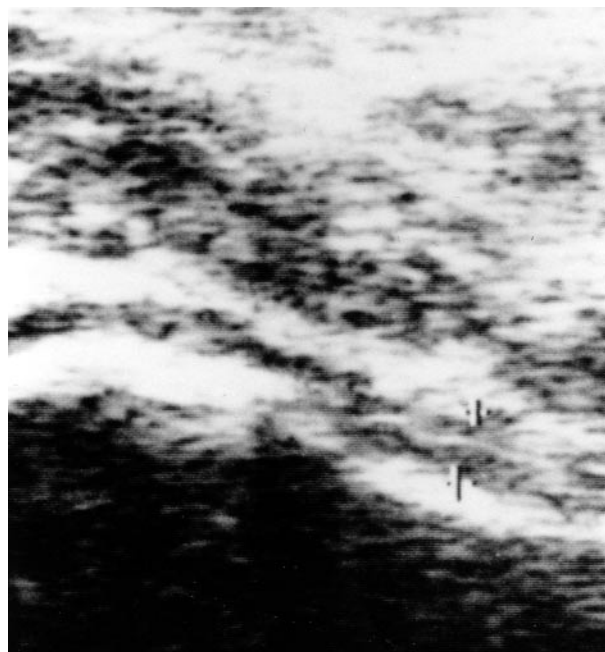


Figure 1. Ultrasonography of a normal hip joint. The 2 markers show the distance between femoral neck (lower mark) and joint capsule (upper mark), which was 0.42 cm.

This distance was measured by the US machine and verified with electronic calipers upon printing of the image. Measurements conducted with the electronic calipers were multiplied by 0.75 to adjust for the magnification when using the Aloka SSD-210DXII at Stony Brook.

Statistical analysis was performed using SPSS for Windows. To assess for significant differences between the control group and the JRA group a t test for equality of means and Levene's test for equality of variances were performed. To determine if the sample size was adequate, a power study was done as well. A p value < 0.05 was considered statistically significant.

RESULTS

A total of 96 ultrasound evaluations of the hip were performed on 48 children. A statistically significant difference in the distance measured from femoral neck to joint capsule was found in the control group compared to the JRA group ($p < 0.001$). In both groups there was no correlation between distance measured and age of subject, and there was no statistically significant difference between the right and left hips (control group $p = 0.99$; JRA group $p = 0.13$). There was also no significant difference between male and female subjects ($p = 0.90$). In addition, other than the presence of an effusion, there was no clear difference on US that could be used to distinguish between a child with JRA and controls. The power ($1 - \beta$) of the study with this sample size was 0.9.

In the control group, the average distance from femoral neck to joint capsule (reported as mean \pm standard deviation) was 0.43 ± 0.08 cm (range 0.27–0.55 cm). In the JRA group, the average distance was 0.60 ± 0.16 cm (range 0.39–1.32 cm). Sonographic imaging showed distention of

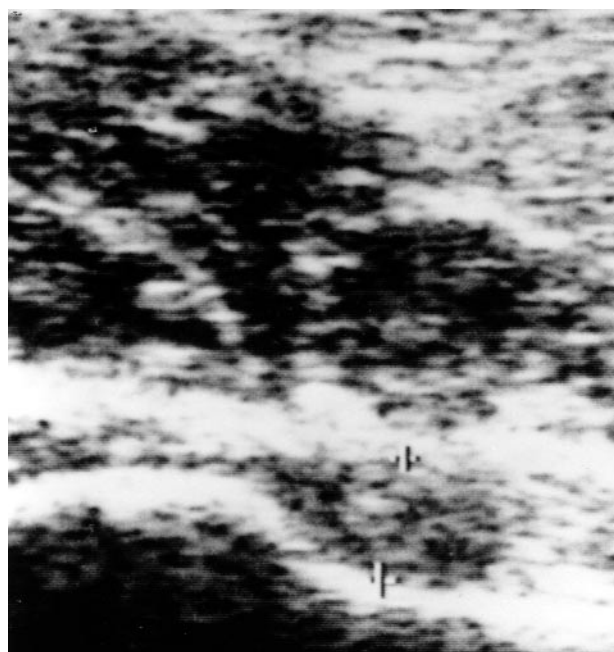


Figure 2. Ultrasonography of a hip from a patient with JRA. The joint capsule is distended, and the distance between the femoral neck and joint capsule shown by the 2 markers is 0.75 cm.

the joint capsule (Figure 2). Two standard deviations above the control group mean was equal to 0.59 cm. Using this value as the standard for the presence of disease, 17 of 24 patients (71%) with JRA had an effusion in at least one hip. Additionally, 6 patients (25%) had effusion bilaterally. Of the 7 patients with JRA but without effusion by the prior standard, 6 had measurements from femoral neck to joint capsule that were at the high end of normal, being greater than one standard deviation above the control group mean (0.51 cm). No control subject had an effusion by this standard. The general characteristics and sonographic findings in the JRA and control groups are given in Table 1.

Overall, there was positive correlation between limitation of range of motion and US joint space in the children with JRA, but this was not consistent in every child. Of the 24 children with JRA, 3 had a normal hip examination bilaterally. Out of these 3, one had an effusion bilaterally on US. The other 2 had negative US examinations, consistent with their physical examinations. Another 16 children had a negative examination in one hip. Of these children, 3 had a positive US in the asymptomatic hip as well as the symptomatic hip. In general, the larger the effusion found on US, the more symptomatic the child.

DISCUSSION

There are no objective laboratory criteria that may be used to conclusively diagnose JRA. Once this diagnosis of exclusion has been made, further classification, based in part on the number of joints involved, may differ between experienced examiners^{9,13}. Ultrasonography has been used in JRA to detect knee involvement^{11,14}, to elucidate the anatomy of synovial cysts¹⁵, and as an objective method of followup, among other uses¹². Early detection of hip involvement is particularly important¹⁶. It is in the detection of swelling in the hip, which is often difficult to palpate, that ultrasonography is also useful.

In the hip, the US joint space is the hypoechoic zone between the femoral neck and joint capsule. It is present in normal hips, because it represents the synovial membrane and a minimal amount of synovial fluid. In diseased hips, it is increased by the presence of synovial inflammation and joint effusion^{17,18}. In this study, the control group had a mean

US joint space of 0.43 ± 0.08 cm. This value is within a range reported in other studies. Bialik, *et al* found a mean of 0.37 ± 0.045 cm in their study of 25 normal hips (18 children and 7 adults)¹⁰. Fedrizzi, *et al* found the mean to be 0.5 ± 0.05 cm in their study of 20 normal hips¹⁷, and Egund, *et al* looked at 19 nonsymptomatic hips and found a mean of 0.53 ± 0.07 cm¹⁹.

There are a number of explanations for these discrepancies. In the study by Egund, *et al*, their measurements were from the ventral aspect of the femoral neck to the ventral aspect of the joint capsule¹⁹. This is in contrast to our study and others, in which measurements were made from the ventral surface of the femoral neck to the posterior surface of the joint capsule^{10,18}. In our study, we measured the greatest distance between femoral neck and joint capsule in the children with JRA as well as in controls, as did Kallio, *et al*, who found similar results¹⁸. Bialik, *et al* did not specifically look at the greatest distance between femoral neck and joint capsule on the control hips, which may account for their lower numbers¹⁰. Fedrizzi, *et al* reported results similar to Egund, *et al*, but they did not state whether their measurements were obtained from the anterior or posterior aspect of the joint capsule¹⁷. This may have resulted in the higher numbers they reported.

Kallio, *et al* had results similar to our own. Their patients had unilateral hip disease and served as their own controls. Their mean ultrasound joint space in normal hips was 0.39 cm, and they found that a 0.2 cm difference above normal, which is equivalent to 0.59 cm, was consistent with an effusion¹⁸. The mean in our study was 0.43 ± 0.08 cm, and 2 SD (0.16 cm) above that was also equal to 0.59 cm. Using this value as the standard for an effusion, 71% of the children with JRA had an effusion in at least one hip, 25% had an effusion bilaterally, and there were no false positives. Additionally, Kallio, *et al* found no correlation between size of the patient and the US joint space, which was consistent with our findings. This finding is explained in the normal hip by the fact that regardless of the size of the patient, the amount of synovial fluid is minimal; and in the diseased hip the greater laxity of the joint capsule in younger children allows greater distention with a smaller volume of fluid¹⁸.

Ultrasonography is a very sensitive tool in the detection of fluid, although there are limitations of its use. It cannot distinguish between what is true joint effusion and what is synovial thickening. Ultrasonography is also limited by its inability to distinguish the cause of effusion^{20,21}, but when it is used in conjunction with an overall clinical picture, it becomes a powerful tool. It is inexpensive, noninvasive, and sensitive in the detection of hip effusion. In conclusion, the value 0.59 cm may be used as the standard for an effusion of the hip joint when measuring ultrasound joint space as described above. Having an objective means of quantifying hip effusion may facilitate the diagnosis, classification, and followup of juvenile rheumatoid arthritis.

Table 1. General characteristics and sonographic findings in controls and JRA group. US joint space refers to the distance measured between the femoral neck and joint capsule.

Variable	Controls	JRA
Mean age (range), yrs	10.1 (4.2–15.9)	10.4 (4.0–15.2)
Sex, F/M	14/10	13/11
Mean US joint space, cm	0.43 ± 0.08	0.60 ± 0.16
Mean US joint space: boys, cm	0.42	0.61
Mean US joint space: girls, cm	0.43	0.60
US joint space, range, cm	0.27–0.55	0.39–1.32

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