

Comparison of a Computer Based Method and the Classical Manual Method for Radiographic Joint Space Width Assessment in Hip Osteoarthritis

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ABSTRACT. Objective. To compare the intraobserver reliability and the sensitivity to change of 2 techniques evaluating the cartilage breakdown in hip osteoarthritis (OA).

Methods. Design: 3 year longitudinal study. Participants: patients with painful hip OA. Outcome: coxofemoral joint space width (JSW) at baseline and at 3 year followup was measured on anteroposterior weight-bearing radiographs by 2 methods: a manual method to obtain JSW at the narrowest point (minimal JSW) using a 0.1 mm graduated magnifying glass and a computer based method to obtain minimal and average JSW. Statistical analysis: Two assessments, at one month interval, of each pair of films; evaluation of the intraobserver reliability using the intraclass coefficient of correlation, and the Bland and Altman approach, obtaining the smallest detectable difference (SDD). For each technique, percentage of progressors was evaluated, i.e., the percentage of patients with change greater than the SDD. Evaluation of sensitivity to change was performed using the standardized response mean (SRM), with 95% CI calculated using the jackknife method.

Results. Twenty-five pairs of films were evaluated. There were no statistically significant differences between the 3 analyses in the calculated intraclass coefficients of correlation, percentage of progressors, or SRM.

Conclusion. These results suggest that both techniques are reliable and sensitive enough to detect changes in a relevant percentage of patients with hip OA after a 3 year followup. (J Rheumatol 2002;29:2592-6)

Key Indexing Terms:

HIP OSTEOARTHRITIS
COMPUTER BASED

JOINT SPACE WIDTH

RADIOLOGICAL ASSESSMENT
REPRODUCIBILITY

The evaluation of potential structure-modifying drugs in hip osteoarthritis (OA) includes structural assessment, such as measurement of joint space width (JSW) at the narrowest point (minimal JSW)¹. However, although this method has been shown to be reliable^{2,3}, the smallest detectable difference (SDD), i.e., the amount of difference for which anything smaller cannot be reliably distinguished from random error in the measurement⁴, was found to be somewhat high^{2,5}.

The use of digital techniques for acquisition and processing of medical images has recently increased⁶⁻⁹. The potential interest is influenced by the possibility of better

reproducibility, and of the evaluation of variables other than minimal JSW, such as the average JSW.

The objectives of this study were to compare the intraobserver reliability and the sensitivity to change of the manual measurement of minimal JSW and of a computer based measurement of both minimal and average JSW.

MATERIALS AND METHODS

Films were obtained from patients with hip OA, aged between 50 and 75 years, with manually measured minimal JSW ≥ 1 mm, no radiographic medial or axial femoral head migration, and no secondary hip OA.

At entry and after 3 years, an anteroposterior weight-bearing pelvic radiograph was obtained, with the lower limbs in $15^\circ \pm 5^\circ$ internal rotation. The x-ray beam was horizontal, perpendicular to the table. The source to film distance was 100 cm. Films were blinded for patient identity and for date.

In the classical manual method, films from a single patient were placed side by side on a light box and the narrowest JSW was selected and measured using a 0.1 mm graduated magnifying glass.

In the computer based method, hip films were scanned using a UMAX tabletop PowerLook II scanner (Umax Data Systems, Fremont, CA, USA) and capture software running in NIH-Image at 10 pixels/mm and 256 gray levels.

JSW of the hip joints was measured using a previously reported program written as a macro function for NIH Image (version 1.61), a public domain program developed at the US National Institutes of Health (Internet address: <http://rsb.info.nih.gov/nih-image/download.html>). The operator manually outlines the joint space by selecting 11 points on each of the inner and outer margins, then the program predicts the complete outline and calculates JSW.

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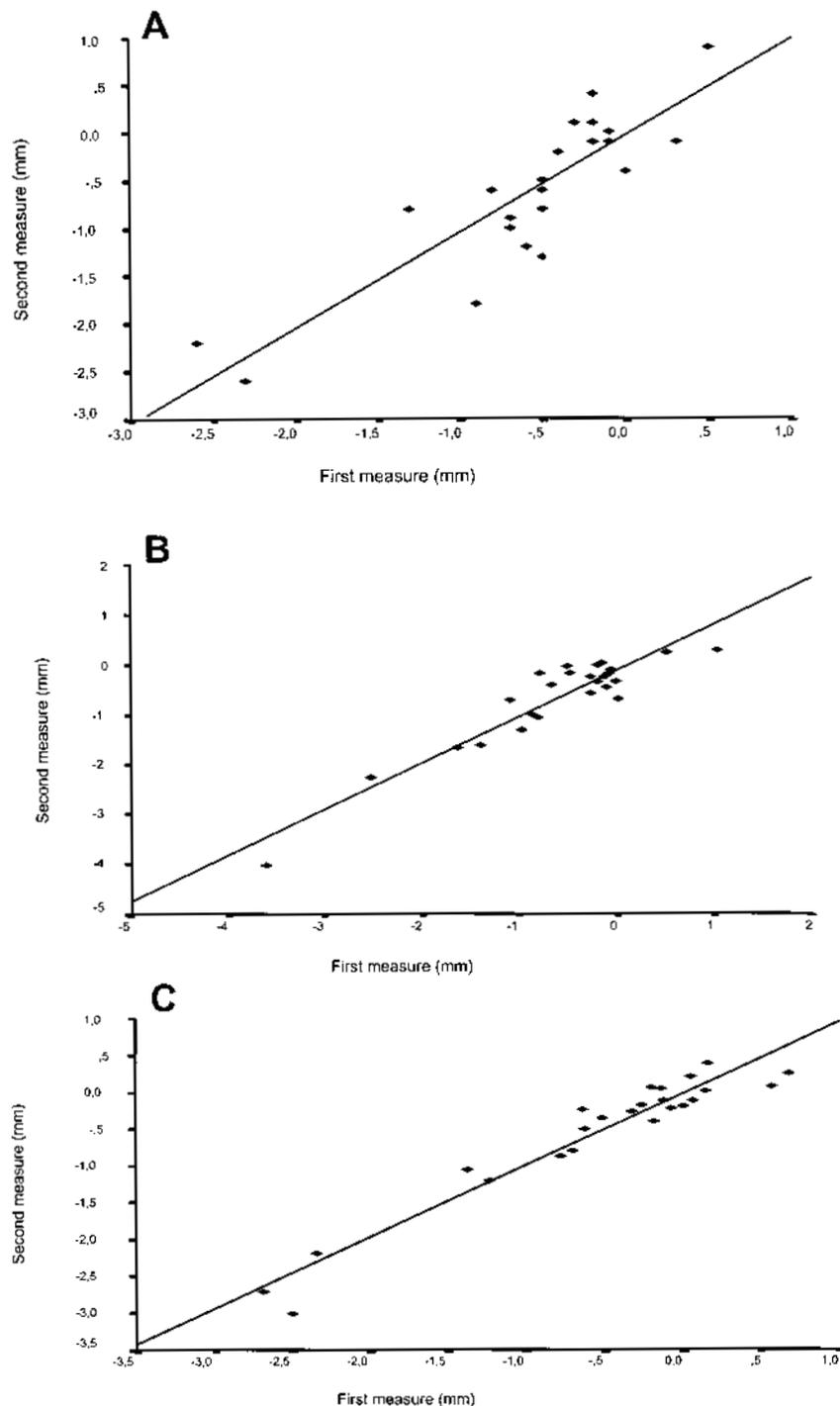


Figure 1. Intraobserver reproducibility of assessment of differences in joint space width (JSW) between baseline and 3 year followup. We conducted 2 assessments, separated by a one month interval, of each pair of films, resulting in 2 measurements of difference in JSW between baseline and 3 year followup. A. Results obtained using the manual measurements of JSW at the narrowest point (minimal JSW); $r^2 = 0.756$, ICC = 0.864 (0.719–0.938). B. Results obtained using the computer based measurements of minimal JSW; $r^2 = 0.874$; ICC = 0.934 (0.858–0.97). C. Results obtained using the computer-based measurements of average JSW; $r^2 = 0.928$, ICC = 0.965 (0.923–0.984). ICC: intraclass coefficient of correlation (95% CI).

In order to correct for any variation in JSW due to parallax (resulting from body rotation, change in weight of subject, alteration of tube through hip to film distance), the size of the femoral head was evaluated using a program written using the Macro procedure in NIH Image. The size of the femoral head between serial films was compared and the mean and minimal JSW were adjusted by assuming that the femoral head remained the same size. Adjusted minimal and average 3 year followup JSW (JSW3) were calculated as [adjusted JSW3 = (femoral head baseline/femoral head 3 yr followup) × JSW3]. Next, the adjusted change in JSW was calculated as [adjusted JSW3 – JSW baseline].

Statistical analysis. We conducted 2 assessments, separated by a one month interval, of each pair of films. In patients with bilateral hip OA, a single, predetermined joint was assessed. Evaluation of the intraobserver reliability used the intraclass coefficient of correlation (ICC), with 95% confidence interval (CI), and the Bland and Altman approach, obtaining the SDD. The percentage of progressors, i.e., the percentage of patients with a change greater than the SDD was calculated using the changes calculated during the first assessment. Sensitivity to change was evaluated on the first measure of each pair of films using the standardized response mean (SRM), with 95% CI calculated using the jackknife method.

RESULTS

Twenty-five pairs of films, from 25 patients (16 men, 9 women), mean age = 63 ± 6 years, mean Lequesne's index = 8 ± 3 (range 3.5–12.5) were evaluated. The computer based measurements, especially of average JSW, demonstrated a higher ICC than the manual measurement, but without reaching statistical significance (Figure 1 and Table 1). The mean difference between repeated measurements of the changes in JSW between baseline and 3 year followup were 0.028, 0.077, and 0.008 mm for manual measurement of minimal JSW, computer based measurement of minimal, and of average JSW, respectively, with standard deviation of 0.39, 0.34, and 0.24 mm, and SDD of 0.78, 0.67, and 0.47 mm, respectively (Table 1). The respective percentages of progressors did not significantly differ (Table 1). The difference between the repeated measurements was not related to the mean of measurements (Figure 2). There was no significant difference in SRM between the methods (Table 1). The reproducibility and sensitivity to change of adjusted and nonadjusted changes in minimal and average JSW were similar (data not shown).

DISCUSSION

In this study, a computer based method of measuring JSW in hip OA was evaluated. This method was utilized in rheumatoid arthritis, with good results⁸, and here was found to be reliable and sensitive enough to detect changes in a relevant percentage of patients with hip OA after a 3 year followup.

The standard deviation for JSW compared to the mean and the mean rate of JSW narrowing were comparable to results observed in previous studies^{7,9}. The reproducibility of measurements was found to be good, comparable to those obtained by experienced operators^{9,10}, with no statistical difference between computer based and manual measurements. However, there was a trend for the computer based measurements, particularly of average JSW, to be more reliable than the manual measures; if this trend proved to be significant in a study using a larger sample size, the difference would mean a smaller number of subjects would be required in therapeutic trials.

The evaluation of JSW results in a continuous variable, which does not permit distinction between the patients with or without disease progression. Different methods have been proposed to convert a continuous into a dichotomous variable¹¹⁻¹⁴, including the SDD. In this study, the SDD were smaller, and the percentage of progressors was higher with the computer based technique, but this finding was not significant. It is difficult to assess whether the lack of significance was due to insufficient statistical power.

Finally, the sensitivity to change, evaluated using SRM¹⁵, was good, with no difference between evaluated methods, and was comparable to results obtained by others⁹.

Computer based measurement of minimal and average JSW demonstrated a similar sensitivity to change and a trend toward a better reliability, compared to the classical manual measure. Other studies are needed for validation.

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Table 1. Metrological properties of different techniques evaluating radiological joint space width (JSW) in hip osteoarthritis. JSW was evaluated twice on 25 pairs of films (baseline and 3 year followup), using a manual measurement of JSW at the narrowest point (minimal JSW) and a computer-based measurement of minimal and average JSW. †

	Baseline, mean ± SD, mm	Change after 3 yrs mean ± SD, mm	ICC (95% CI)	SDD mm	Progressors [†] , % (95% CI)	SRM (95% CI)
Manual measure of minimal JSW	1.89 ± 0.7	-0.53 ± 0.69	0.864 (0.719–0.938)	0.78	28 (10–46)	-0.77 (-1.03, -0.44)
Computer based measure of minimal JSW	2.52 ± 0.85	-0.6 ± 0.95	0.934 (0.858–0.97)	0.67	40 (21–59)	-0.64 (-0.93, -0.29)
Computer based measure of average JSW	3.4 ± 0.79	-0.53 ± 0.88	0.965 (0.923–0.984)	0.47	44 (23–66)	-0.61 (-0.9, -0.31)

† As defined using SDD. SDD: smallest detectable difference (1.96 x SD of the differences between repeated measurements of JSW change). SRM: standardized response mean: ratio between the mean change at 3 yrs vs baseline and SD of changes. ICC: intraclass coefficients of correlation.

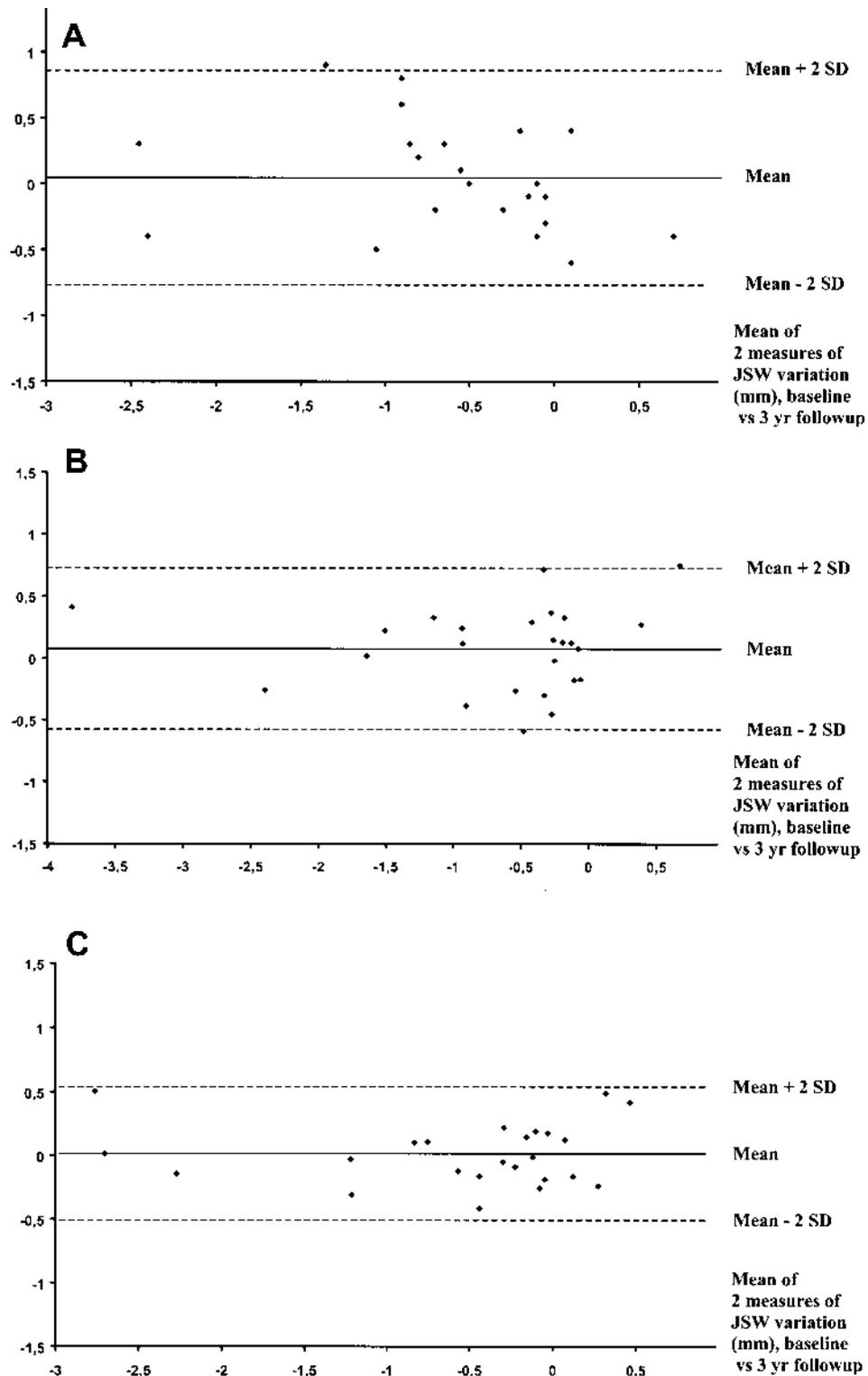


Figure 2. Intraobserver reproducibility of assessment of differences in joint space width (JSW) between baseline and 3 year followup: Bland and Altman plotting method. We conducted 2 assessments, separated by a one month interval, of each pair of films, resulting in 2 measurements of difference in JSW between baseline and 3 year followup. A. Results obtained using the manual measurements of JSW at the narrowest point (minimal JSW). B. Results obtained using the computer based measurements of minimal JSW. C. Results obtained using the computer based measurements of average JSW. Limits of agreement correspond to mean difference between 2 measurements \pm 2 SD.

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