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A comparison of the Metrecom skeletal analysis system vs plain film radiography in the measurement of sacral base angle and lumbar lordosis

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Fifteen male subjects were examined by a computerized three dimensional goniometer known as the Metrecom Skeletal Analysis System (Version 1.1) and by lumbar radiographs. Metrecom measurements of sacral base angle (Ferguson's angle) and lumbar lordosis were compared to the same measurements taken from lateral lumbar radiographs. Data was analyzed using Pearson correlation coefficients. The Pearson correlation between Metrecom and radiographic sacral base angle yielded r = .236 and between Metrecom and radiographic lordosis angle was r = .519. Significant differences between radiographic sacral base angle vs Metrecom and radiographic lumbar lordosis angle vs Metrecom were found. This study suggests that the Metrecom Skeletal Analysis System (Version 1.1) has a weak association with plain film radiography in the measurement of sacral base and lumbar lordosis angle and that there is a statistically significant difference between the Metrecom and radiographic measures, as evaluated in the experiment.
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KEY WORDS: Metrecom, lumbar lordosis, Ferguson's angle, electrogoniometer, posture, chiropractic.

Quinze sujets mâles ont été examinés à l'aide d'un goniomètre à trois dimensions électronique connu sous le nom de Metrecom Skeletal Analysis System (Version 1.1) et par des radiogrammes lombaires. Les mesures Metrecom de l'angle de base sacrée (angle de Ferguson) et d'une lordose lombaire ont été comparées aux mêmes mesures prises à partir de radiogrammes lombaires latéraux. Les données ont été analysées en utilisant les coefficients de corrélation de Pearson. La corrélation de Pearson entre le Metrecom et l'angle de base sacrée radiographique était de r = 0,236 et celle entre le Metrecom et les angles de lordose radiographiques était de r = 0,519. Des différences significatives ont été observées entre l'angle de base sacrée radiographique par rapport à celui du Metrecom et l'angle de lordose lombaire radiographique par rapport à celui du Metrecom. Cette étude suggère qu'il existe une faible relation entre le Metrecom Skeletal Analysis System (Version 1.1) et la radiographie standard de la mesure de l'angle de la base sacrée et de la lordose lombaire, et qu'il existe une différence statistiquement significative entre les mesures avec le Metrecom et la radiographie, comme il a été évalué dans l'expérience.
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MOTS CLÉS : Metrecom, lordose lombaire, angle de Ferguson, électrogoniomètre, posture, chiropratique.

Introduction

Various designs of non-radiographic posture measuring methods and devices have been used both clinically and experimentally to assess spinal position and mechanics. These include the plumbline analysis,[1,4] posturometer,[1] JPEI-METER,[2] thermography,[3] photography,[4] goniometry[5,6] and the electrogoniometer.[7,8]

Recently a computerized electrogoniometer, known as the Metrecom Spinal Analysis System (Version 1.1) (Faro Medical Technologies Inc., Montreal, Canada), was developed for clinical use. This device was designed to measure the osseous spacial arrangement of the spine, pelvis, upper and lower limb segments (Figure 1). Computer printouts produce a sagittal and frontal schematic image of the body part analyzed and indicate osseous displacement from the central plane including internal and external rotation, flexion, extension, and spinal curves (Figure 2).

Plain film radiography is often used in the clinical investigation of lumbar associated spinal complaints.[9] Examination of the upright lateral lumbar radiograph also yields certain measurements, including the lumbar lordosis and the sacral base (Ferguson's) angle.

This study compared the Metrecom skeletal analysis system to plain film radiography in the measurements of sacral base angle and lumbar lordosis.

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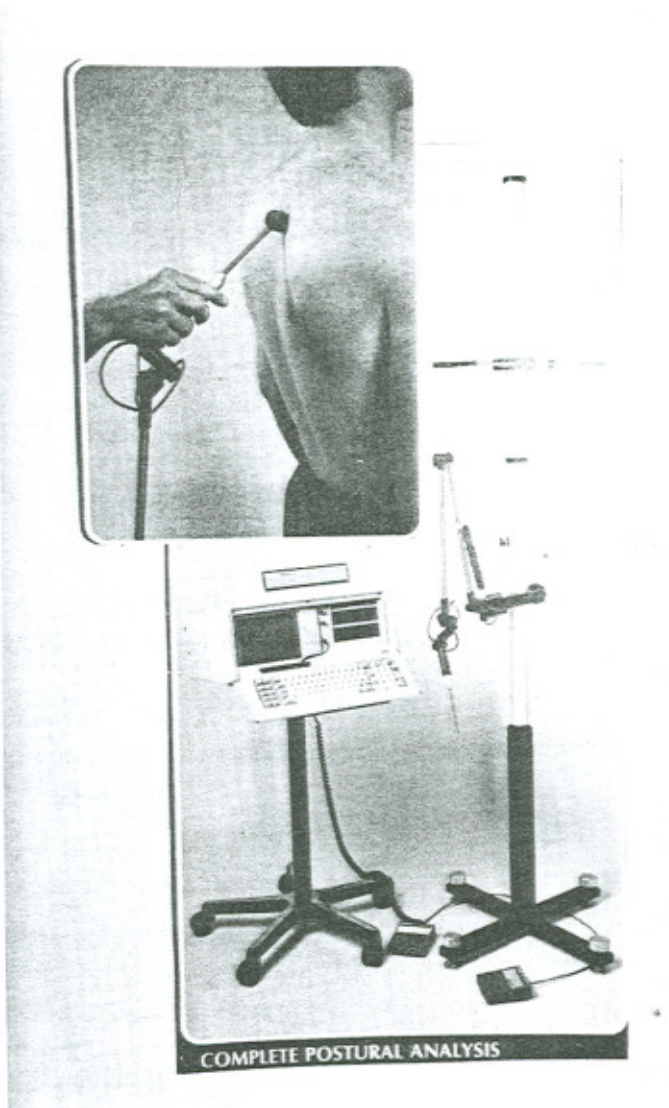


Figure 1 Metrecom skeletal analysis system composed of computer and software program, stand and digitizing probe (inset photo).

Method

Fifteen male subjects with a mean age of 25.8 (SD ± 6.3) underwent spinal analysis using the Metrecom Skeletal Analysis System (Version 1.1) and concurrent radiographic examination of the lumbar spine. One examiner, experienced in the use of the Metrecom, examined each patient once.

Metrecom analysis was conducted according to the guidelines for skeletal analysis outlined in the Metrecom manual. (Faro Laboratories, 1986.) Each subject was positioned upright on a foot plate measuring 24″ × 40″. The x-ray bucky and Metrecom digitizing probe were positioned at 90 degrees to each other. This was done to prevent excessive movement during both the radiographic and Metrecom evaluations. Radiographs of the lumbar spine were taken using a 40″ tube bucky distance followed by Metrecom analysis without subject repositioning.

The spinal analysis using the Metrecom was performed by digitizing the following anatomical landmarks: the left posterior iliac spine (PSIS), the right PSIS, the spinous process (SP) of L5, and the SP C7. Upon prompting from the Metrecom program, the digitizing probe was run from the SP C7 along each SP to that of S4. The resultant input was then stored and angles were computed via the Metrecom internal software program.

No restraining straps were used although a stabilizing arm attached to the Metrecom stand was utilized in an effort to prevent excessive subject sway. All Metrecom analysis and radiographs were taken by one examiner.

Measurements for standing lumbar radiographs and sacral base (Ferguson's) angle and lumbar lordotic angle were performed according to protocol previously described by Yochum and Rowe.[10]

All Metrecom generated angular measurements were tabulated in conjunction with data obtained from radiographic analysis. Pearson correlation coefficient and T-test analysis were then calculated from all collected data. Metrecom values were plotted vs radiographic values and differences were analyzed.

Results

Fifteen subjects were used to analyze the sacral base angle; but only 14 were used for the lumbar lordosis reading, as one subject was excluded because of an inadequate x-ray.

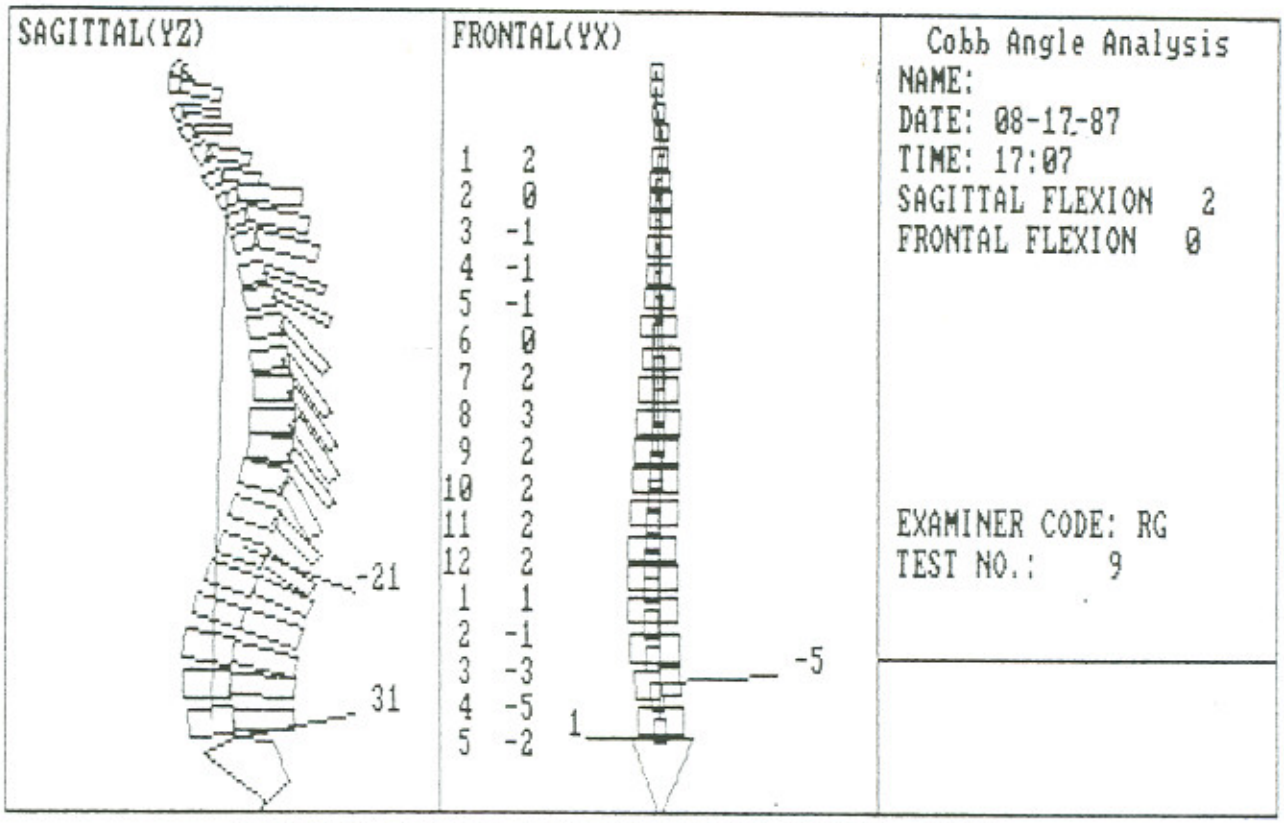
Lumbar radiographic analysis indicated the mean sacral base angle to be 39.4 degrees (SD ± 8.2), whereas Metrecom analysis determined a mean value of 27.9 degrees (SD ± 10.3). The mean lumbar lordotic measurement obtained by radiographic analysis was 58.6 degrees (SD ± 4.9) and Metrecom analysis indicated a value of 19.6 degrees (SD ± 8.3) for this parameter. Figures 3 and 4 graphically display the radiographic versus Metrecom angles for sacral base angles and the lumbar lordosis, respectively.

Pearson correlation between radiographic and Metrecom sacral base angles and lumbar lordotic angles yielded the following results, $r = .236$; $r = .519$, respectively.

Paired sample T-tests on radiograph sacral base angles vs Metrecom resulted in $T = 3.969$; $p < .001$. Paired sample T-tests of radiograph lumbar lordosis angles vs Metrecom resulted in $T = 20.574$; $p < .001$.

Discussion

The observed radiographic sacral base angles and lumbar lordosis angles were representative of those found in the literature where average sacral base angles range from 30 degrees to 43 degrees[11] and lumbar lordosis from 23 degrees to 68 degrees.[12,13,14] As was observed in this study, such angles



SIDE VIEW — COBB ANGLE ANALYSIS — TEST NO.: 9

		END-VERTEBRAE	COBB ANGLE
KYPHOSIS (T1/T12):	45		
LORDOSIS (L1/L5):	28	L4 / S	5
SACRAL BASE ANGLE:	32		

FRONT VIEW

SACRAL ANGLE: 0(POS.:RIGHT INF.,NEG.:LEFT INF.)

Figure 2 Sample Metrecom skeletal analysis printout showing sagittal and frontal spinal image. Sacral base angle and lumbar lordosis are posted in table below sinal image.

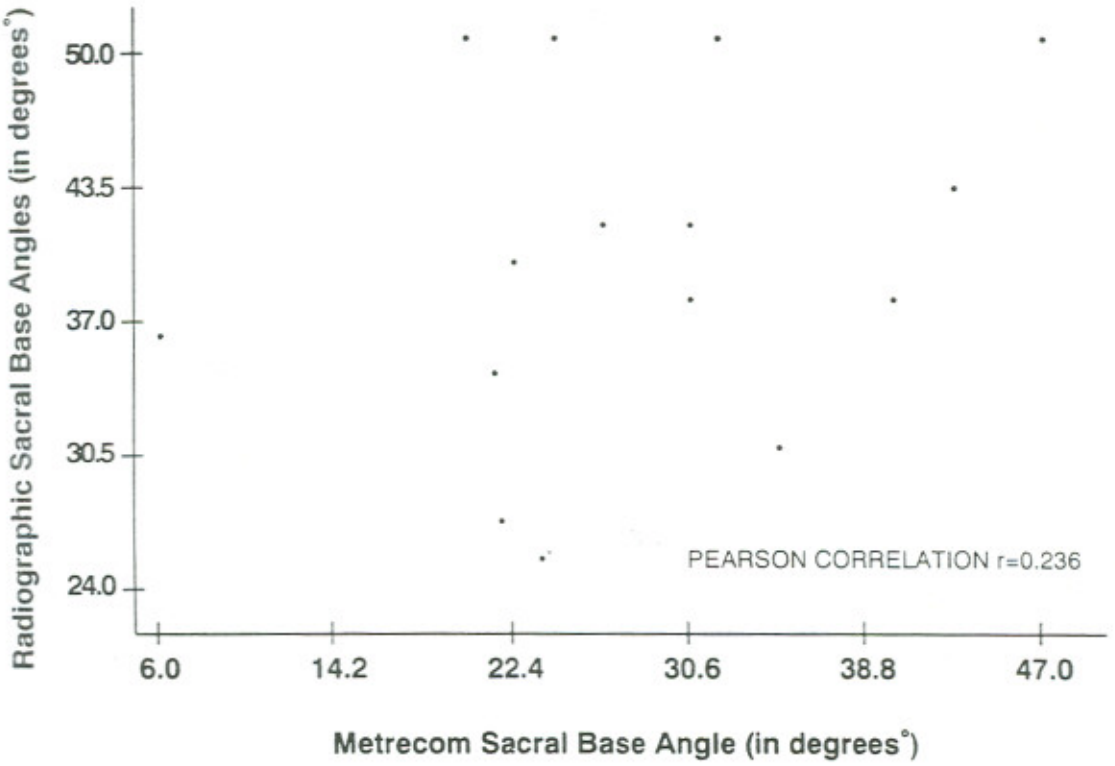


Figure 3
Plot showing radiographic sacral base angles vs sacral base angles for each subject.

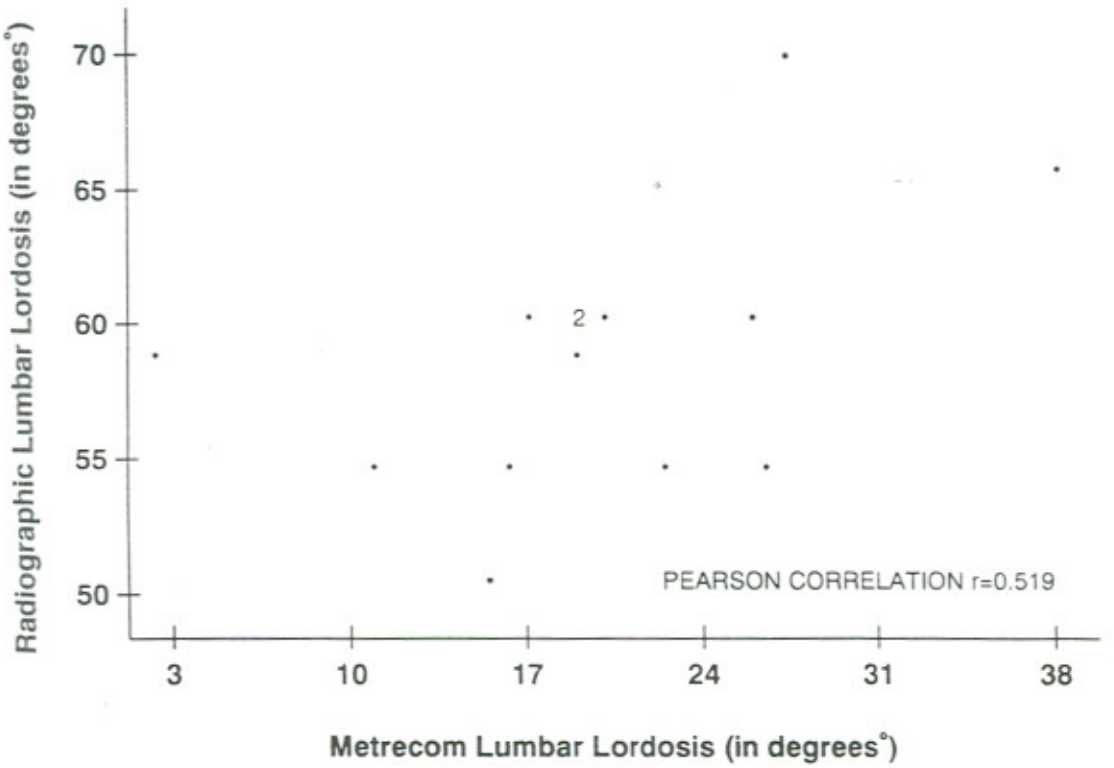


Figure 4
Plot showing radiographic lumbar lordosis angles vs Metrecom lumbar lordosis angles for each subject.

tended to be greater with the subject assuming an upright posture.[12]

Results of this study indicated that the relationship between radiographic and Metrecom measured sacral base angles is weak (r = .236). The relationship between the radiographic analysis of the lordosis and the Metrecom measured lumbar lordosis was moderate (r = .519). This is seen in Figure 3 and 4, where the plots reflect the lack of a linear relationship between the measures.

Paired T-test analysis indicated a significant difference between Metrecom and radiographic measurements for both sacral base and lumbar lordotic angles. This finding supports the notion that the angles derived by the Metrecom and radiographs are not the same, reinforcing the weak relationship between the two methods.

Faro Technologies claim an inherent error variability in the order of 5% for the Metrecom analyzer. Variations observed between radiographs and Metrecom measures in the present study were determined to be greater than the ± 5% indicated by the manufacturer. Subsequent to consultation with the manufacturer, it was discovered that Metrecom Version 1.1 employs a different method of calculating sacral base angle than the accepted standard radiographic measurement of sacral base angle as outlined.[15] (Personal communication with Faro Technologies, October 1990.) Therefore, whether the Metrecom angle is an accurate approximation of the sacral base angle as outlined by Ferguson, may now be considered to be a matter of dispute. We suggest that such inconsistency may well serve to explain the large discrepancy demonstrated by our findings. Further, it was noted that when conducting Metrecom analysis, should the digitizing probe be lifted prior to conclusion, wide variations in sacral base angle measurements may result. (Personal communication with Faro Technologies, October 1990.)

Previously, Metrecom utilizaton indicated that correlation coefficients for inter-examiner values were above r = .9 and all p values less than .001.[16] Unfortunately, this study could not confirm this value, as multiple readings were not performed.

Similarly, Metrecom measurement of lumbar lordosis is calculated differently than standard radiographic lumbar lordosis measurement techniques. Metrecom instrumentation measures the sum of the angles between the five idealized lumbar vertebrae generated by the computer. Such angles are determined by a line running through the central body of the vertebrae and not at the extreme superior and inferior vertebral endplates. (Personal communication with Faro Technologies, October 1990.) Radiographically lumbar lordosis measurements are derived from the angle formed from the perpendiculars to the line parallel to the superior endplate of the first lumbar vertebrae and inferior endplate of the fifth lumbar vertebrae.[10]

With differences in angle calculations, questions may arise as to whether sacral base angles and lumbar lordosis angles produced by the Metrecom skeletal analysis are in fact the same as those traditionally measured on plain film radiographs.

Conclusion

This study indicates a weak relationship between Metrecom sacral base angles and radiographic sacral base angles, when the software version 1.1 is employed. A moderate relationship between Metrecom lumbar lordosis and radiographic lumbar lordosis was noted. T-tests revealed that there is a statistically significant difference between the Metrecom and radiographic values for both sacral base and lumbar lordosis angles.

References

1 Vernon H. An assessment of the intra and inter-reliability of the posturometer. J Manipulative Physiol Ther 1983; 6(2):57–60.
2 Jenness ME. Inter-examiner reliability evaluation of a new biomechanical measuring device. The American Chiropractor 1988; July:46–50, 61.
3 Jenness ME. The role of thermography and postural measurement in structural diagnosis. In Goldstein M (ed). Research Status of Spinal Manipulative Therapy. NINDCS Monograph NO. 15 Washington DHEW, 1975.
4 Brown EV. A comparison of radiographic postural analysis and photographic postural analysis. The Digest of Chiropractic Economics 1983; Jan/Feb:41.
5 Moore ML. The measurement of joint motion. Part 2. The technique of goniometry. Phys Ther Rev 1949; 29:56–264.
6 Portek I, Pearcy MJ, Reader GP, Mowat AG. Correlation between radiographic and clinical measurement of lumbar spine movement. British Rheumatology 1983; 22:197–205.
7 Nansel D, Peneff A, Cremata E, Carlson J. Time course considerations for the effects of unilateral lower cervical adjustments with respect to the amelioration of cervical lateral-flexion passive end-range asymmetry. J Manipulative Physiol Ther 1990; 13(6):299–304.
8 Quanbury A, Cooper J, Grahame R. An electrogoniometer for the measurement of thoracolumbar rotation. J Biomechanics 1986; 19(10):791–797.
9 Hildebrandt RW. Chiropractic spinography and postural roentgenology part 2 clinical basis. J Manipulative Physiol Ther 1981; 4(4):191–201.
10 Yockum T, Rowe L. Essentials of skeletal radiology. 1st Ed. Baltimore: Williams and Wilkins, 1987:188–189.
11 Busche-McGregor M, Naiman J, Grice AS. Analysis of the lumbar lordosis in an asymptomatic population of young adults. J Can Chiropr Assoc 1981; 25(2):58–64.
12 Fernand R, Fox DE. Evaluation of lumbar lordosis A prospective and retrospective study. Spine 1985; 10(5):799–800.
13 Hellems HK, Keats TE. Measurement of the normal lumbosacral angle. Am J Roentgenol Radium Ther Nucl Med 1971; 113(4):642–645.
14 Jessen AR. An in-depth study of the lumbosacral angle in patients with low back pain. J Can Chiropr Assoc 1973; 17(1):31–34.
15 Fergusson AB. The clinical and roentgenographic interpretation of lumbosacral anomalies. Radiology 1934; 22:551.
16 Adams AA, Lopez D, Loucks JA, Wilds, Lawless P. Intra- and inter-examiner reliability of plumbline posture analysis measurements using a three-dimensional electrogoniometer. Research Forum 1988; 4(3):60–72.