

Measurement of limb length inequality

Comparison of clinical methods with orthoradiography in 190 children

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We studied the agreement in measuring limb length inequality with orthoradiograms and clinical methods. In 190 children attending our Limb Length Clinic for the first time, 95% of the measurements with wooden boards was within -1.4 and $+1.6$ cm of the results of the orthoradiograms. A tape measure had significantly less agreement.

The predictive value of a localization of the main

limb length inequality above the knee, as found with a tape measure, was 64% and for a localization of the main limb length inequality below the knee 75%.

A Wooden Board Reliability Graph is presented, which can be helpful in the decision to perform orthoradiographic measurements of limb length inequality in, e.g., evaluation of impairment.

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Radiographic methods for measuring limb length inequality (LLI) are most accurate but, in daily practice, measurements with wooden boards or a tape measure are commonly used. Wooden boards are considered to be more precise than a tape measure, but a direct comparison of both methods is poorly documented (Clarke 1972, Eichler 1972, Friberg et al. 1988). The purpose of a tape measure seems primarily to be the assessment of the localization of the main LLI, i.e., above or below the knee. In this study, we compared both clinical methods with orthoradiograms in 190 children attending our Limb Length Clinic.

Patients and methods

We used the data from the first visit of 190 children to our Limb Length Clinic between 1981 and 1994.

All clinical measurements were done by one person (A.D.), who was not informed of the results of the orthoradiograms.

159 patients were examined in the standing position, with straight knees. Wooden boards of different thicknesses were placed under the short limb until the iliac crests were level, according to Morscher (1972) and Carey (1991). In the remaining 31 patients, such measurements were not made because they could not stand or they had lower limb contractures or equinus deformity of the feet. With a tape measure, the distances from the anterior superior iliac spine to the medial knee jointline, and from the medial knee joint-

line to the tip of the medial malleolus, were determined to the nearest 0.5 cm, while the patient was in supine position.

Total LLI and lengths of femur and tibia were measured by orthoradiography, as described by Taillard (1956). These measurements were performed by one of two authors.

In each patient a comparison between the various methods was made by subtracting the outcome of the clinical measurement from the LLI found with the orthoradiogram, and thereafter analyzed with the variance ratio test (F-test, SPSS software). The significance level was set at 0.05. The mean difference and the 95% limits of agreement (mean \pm 2 SD) were calculated according to Bland and Altman (1986). Regression analysis was used to design a reliability graph, which makes it possible to estimate intervals of the real LLI, if measured radiographically.

The predictive value of the tape measure in localizing the main LLI above or below the knee was also calculated.

Results

The measurements with tape showed less agreement than those with wooden boards and they were less precise (Table 1).

The accuracy of the clinical measurements appeared to be independent of the magnitude of the LLI (Figures 1 and 2).

Table 1. Agreement of clinical methods with orthoradiograms. Mean SD difference and 95% limits of agreement

	Difference (cm)		95% limits
Wooden boards, n 159	0.09	0.78	-1.4 / 1.6
Tape measure, n 190	0.14	0.97	-1.8 / 2.1

p 0.002, F-test.

The predictive value for localization of the main LLI above the knee, as found with a tape measure, was 64% and for localization below the knee 75% (Table 2).

Orthoradiogram – wooden boards

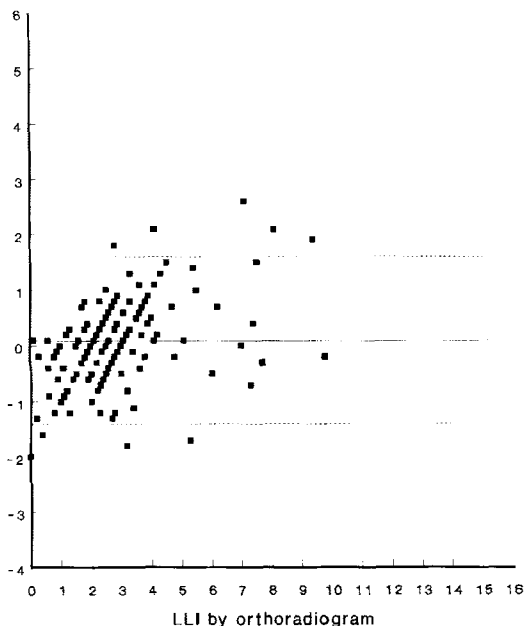


Figure 1. The differences in measurement of LLI between orthoradiogram and wooden boards (n 159). 95 percent limits of agreement.

Orthoradiogram – tape measure

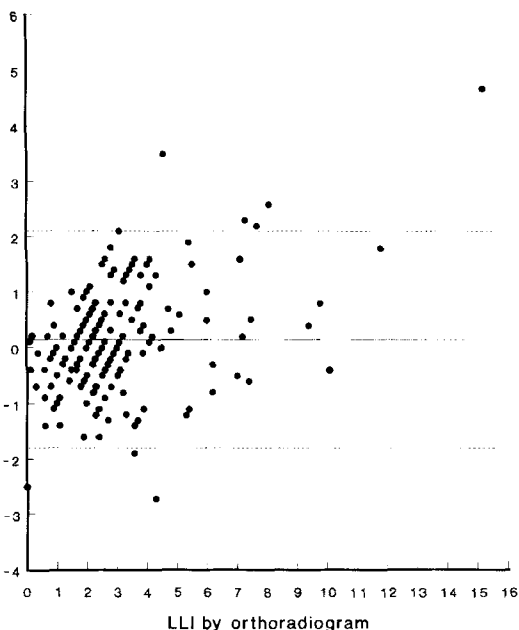


Figure 2. The differences in measurement of LLI between orthoradiogram and tape measure (n 190). 95 percent limits of agreement.

Figure 3. Wooden Board Reliability Graph. The graph predicts real (orthoradiographic) LLI, based on knowledge of the LLI obtained with wooden boards. Various intervals, indicated by percentiles, can be estimated. Example. During clinical examination a LLI of 1.5 cm is found with the use of wooden boards. In the graph, the vertical line at 1.5 cm on the x-axis crosses the 10- and 90-percent lines at about 0.6 cm and 2.6 cm on the y-axis. This means an 80% chance that the real (orthoradiographic) LLI is between 0.6 and 2.6 cm. In the same way a 20% chance can be found that the real LLI is about 1.0 cm or less.

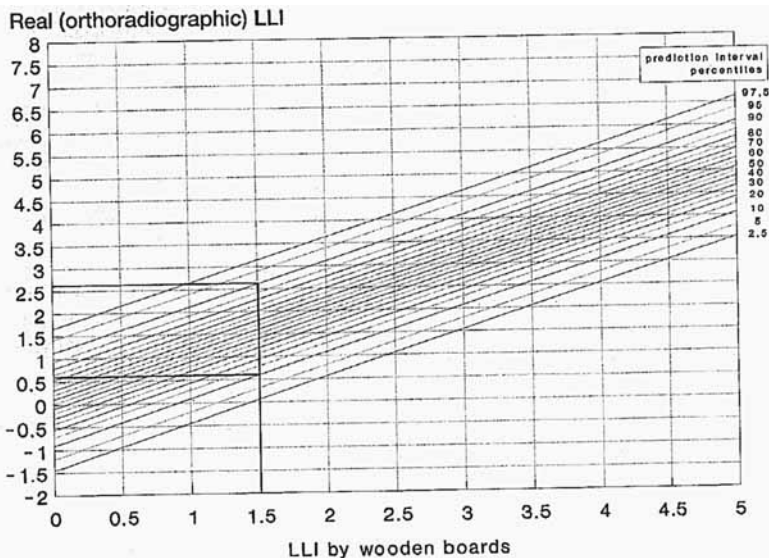


Table 2. Localization of the main limb length inequality

	Tape-measure		
	Below the knee ^a	Above the knee ^b	No difference
Orthoradiograms			
Below the knee	60	28	17
Above the knee	19	53	10
No difference	1	2	0

^a Predictive value for LLI below the knee 60/80 = 0.75

^b above 53/83 = 0.64.

Discussion

The use of a tape measure to assess the localization of the main LLI had a limited value. In measuring the total amount of LLI, tape measures could perhaps have been more precise, if the measurements had been done directly from the anterior iliac spine to the medial malleolus, instead of adding the distances above and below the knee.

According to our study, 95% of the measurements of LLI with wooden boards will be within about 1.5 cm of the measurements made with orthoradiograms. From a study on 21 adults with low back pain (Friberg et al. 1988), the same agreement for wooden boards can be calculated.

Individual skills and experience influence the reliability of clinical methods considerably. The interobserver variation has been reported to result in 60% disagreement among 4 doctors, when 0.6 cm was the criterion for a "short leg" (Nichols and Bailey 1955). For our study, with one experienced examiner, this is of minor interest.

To illustrate the clinical implications of our study, the Wooden Board Reliability Graph (Figure 3) was designed. With help of this graph, the reliability of a certain measurement with wooden boards can be estimated, after which the clinician can decide to perform an orthoradiogram as well.

There is no consensus on the amount of LLI that is clinically important (Menelaus 1991). In any case, in posttraumatic LLI of 2 cm or more, some impairment is thought to be present according to the widely used Guides to the Evaluation of Permanent Impairment (American Medical Association 1993). The conse-

quences of our study for the diagnosis of such impairment are shown by the Reliability Graph (Figure 3). It appears that only if a LLI found with wooden boards is less than 0.5 cm, does the possibility that the real LLI is more than 2.0 cm become acceptably small. Therefore in examinations for insurance matters during which a clinical LLI greater than 0.5 cm is found, the recommendation by the AMA guides to perform an orthoradiogram is supported by our findings.

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