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Leg-length Inequality has Poor Correlation with Lumbar Scoliosis

A Radiological Study of 100 Patients with Chronic Low-back Pain

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Summary. Leg-length inequality and its hypothetical consequences, pelvic tilt and lumbar scoliosis, were measured in 100 young or middle-aged adults suffering from chronic low-back pain. Leg-length inequality had a good correlation with the pelvic tilt assessed from the iliac crests, a moderate correlation with the sacral tilt, but a poor correlation with the lumbar scoliosis. The sacral tilt correlated well with the lumbar scoliosis when the tilt was more than 3° but poorly when it was smaller. Thus, there is a gradually decreasing correlation between the posture parameters when moving from the hips up to the lumbar spine. We conclude that before a radiologically observed leg-length inequality be considered as the cause of low-back pain, an erect-posture radiograph of the whole pelvis and lumbar spine is essential, in order to assess an existing pelvic tilt and scoliosis.

An association between leg-length inequality (LLI) and low-back pain has been known for decades. It is even likely that the amount of disability is proportional to the degree of LLI [1, 3]. According to a logical sequence of events, LLI might cause pelvic tilt, followed by a compensatory scoliosis of the spine toward the shorter leg [2, 3, 14]. Consequent abnormal loading of the lumbar spine has been suggested to be the cause of low-back pain [6, 9]. This suggestion has not been confirmed, however.

The purpose of the present study was to analyze the correlations between LLI, pelvic tilt, and lumbar scoliosis to find out if LLI is followed by pelvic tilt and compensatory scoliosis of the spine in patients with chronic low-back pain of unknown origin.

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Patients and Methods

One hundred patients, 53 men and 47 women with a mean age of 40 years (SD 7 years), who were admitted to the Orthopedic Hospital of the Invalid Foundation, Helsinki, Finland, for a thorough investigation of chronic low-back pain were included in the study. They had all undergone previous conservative treatment as outpatients. Patients with primary scoliosis of the spine, spondylolysis, spondylolisthesis, or other structural pathologies of the spine with the exception of moderate degenerative changes were excluded from the study. No one had osteoarthrotic changes in the hip joints.

Erect posture radiographs were taken according to the principles described by Gofton and Trueman [10]. The patient stood with straight knees with a block 15 cm wide between the feet. A plumb line was used as a reference line for the measurements. LLI was defined as the height difference between vertices of the lower extremities (Fig. 1). Iliac crest tilt and sacral tilt were expressed as the angle between their upper surfaces and the horizontal line (Fig. 1). Lumbar scoliosis was measured according to the method of Cobb [4]. Student's *t*-test was used in the statistical analyses.

Results

The mean LLI (± SD) was 5 mm (± 3). In 56 cases the right leg was shorter (on the average 5 mm) than the left one, and in 36 cases the left one was shorter (on the average 5 mm) (Fig. 2).

The convexity of the lumbar scoliosis was to the left in 36 cases and to the right in 46 cases. In 13 cases the scoliotic curve was 10° or more (Fig. 2). The LLI correlated well with the iliac crest tilt, moderately with the sacral tilt, and poorly with the lumbar scoliosis (Fig. 1). The iliac crest tilt correlated well with the sacral tilt and moderately with the lumbar scoliosis (Fig. 1). The sacral tilt correlated moderately with the lumbar scoliosis when all the cases were considered, poorly in cases where the sacral tilt was less

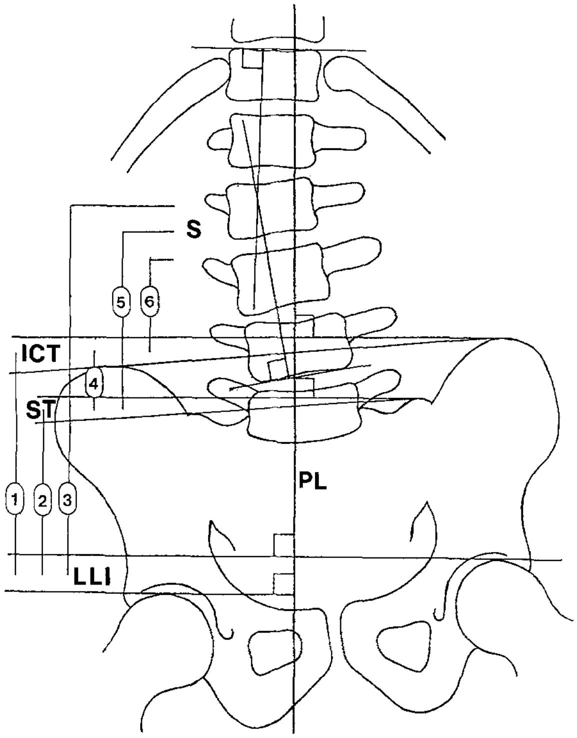

Fig. 1. Correlations between the leg-length inequality *(LLI)*, iliac crest tilt *(ICT)*, sacral tilt *(ST)*, and lumbar scoliosis *(S)* measured using a plumb-line *(PL)* as the reference line in 100 patients with chronic low-back pain. *1*, LLI – ICT: $r = 0.843$, $P < 0.001$; *2*, LLI – ST: $r = 0.639$, $P < 0.001$; *3*, LLI – S: $r = 0.338$, $P < 0.001$; *4*, ICT – ST: $r = 0.747$, $P < 0.001$; *5*, ST – S: $r = 0.561$, $P < 0.001$; *6*, ICT – S: $r = 0.530$, $P < 0.001$

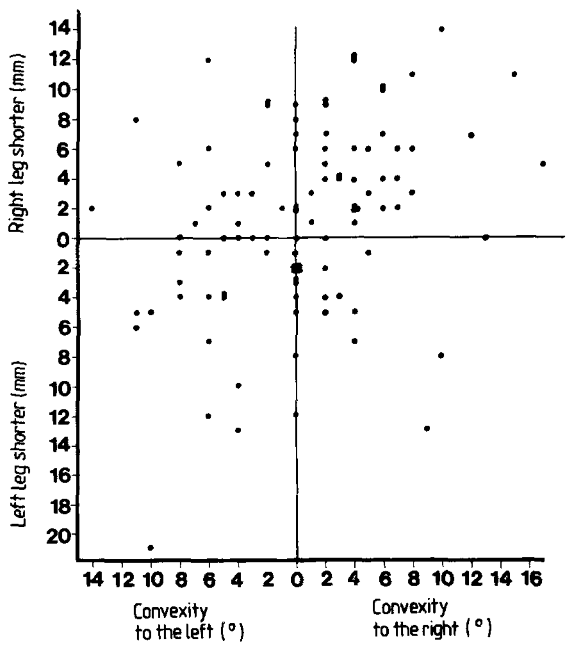

Fig. 2. Distribution of the leg-length inequality and lumbar scoliosis in 100 patients with chronic low-back pain

than 3° ($n = 65$, $r = 0.285$, $P < 0.01$), and well in the cases where the sacral tilt was 3° or more ($n = 35$, $r = 0.711$, $P < 0.001$).

Discussion

In their study of 1000 patients with low-back pain, Rush and Steiner [14] reported that a compensatory scoliosis existed whenever there was a difference in the leg lengths, and that the degree of scoliosis was proportionate to the degree of pelvic tilt. However, no data confirming this view were presented. On the contrary, there is evidence that LLI of more than 1 cm may exist without any symptoms [5–8, 12–14]. Moreover, pelvic tilt and the convexity of the lumbar scoliosis may occur on the side of the longer leg [11].

In the present study the right leg was shorter more frequently than the left one, which is in accord with previous reports [6, 11]. The LLI had a declining correlation with its hypothetical consequences – pelvic tilt and lumbar scoliosis – the further these possible consequences were followed. The critical point was the lumbosacral junction, as the LLI, iliac crest tilt, and sacral tilt correlated well with each other, but the LLI correlated poorly and the iliac crest tilt and the sacral tilt only moderately with the lumbar scoliosis. Most of our patients had only minor LLI. There were ten patients with an LLI of more than 10 mm, but even in these cases the LLI had a poor correlation with the lumbar scoliosis. In four of these ten cases the convexity of the lumbar scoliosis was on the side of the longer leg. Papaioannou et al. [13] observed a good correlation between sacral tilt and lumbar scoliosis, but the scoliosis was minor in the patients with an LLI of less than 22 mm. Those of our patients who had a sacral tilt of 3° or more showed a good correlation between the sacral tilt and lumbar scoliosis but a poor correlation between the LLI and sacral tilt. Hence, it is probable that minor LLI is not a significant factor in sacral tilt and lumbar scoliosis, and that anatomic variations of the pelvis, lumbosacral junction, and lumbar spine determine the degree and direction of the scoliotic curve. Only when the sacral tilt is great enough does it cause a compensatory lumbar scoliosis proportional to the magnitude of the pelvic tilt.

We suggest that, although LLI may be associated with low-back pain, even a high correlation between LLI and low-back pain does not necessarily indicate causation. If the reason for chronic low-back pain is obscure and LLI is suspected, functional erect-posture radiographs are mandatory to reveal whether the LLI is really great enough to cause a sacral tilt and a scoliotic convex curve of the lumbar spine on the side of the shorter leg.

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