Chiropractic Neurology Research Brief

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Leg Length Inequality

Introduction

Leg length inequality (LLI) exists in 40-70 percent of the population (1). The etiologies include: unilateral foot pronation, degenerative joint disease of the hip, knee and ankle, congenital hip dysplasia, avascular necrosis of the hip, fracture and knee and hip replacements. However, according to Taylor (2), the majority of LLI cases are due to asymmetric growth rates at the epiphyseal plates of the long bones of the lower extremities).

Biomechanical Implications

LLI often causes adverse effects on spinal, pelvic/sacrum and lower extremity biomechanics with pelvic/sacral obliquity most common. It causes a compensatory convex lumbar scoliosis and laterality of the thorax toward the short leg side (3).

Predispositions: Hip Pain, Sciatica and Fatigue

According to Gofton (7), LLIs as little as 1.2-2.5 cm is associated with osteoarthritis of the hip on the long leg side. A gait study by Bhave et al (4), demonstrated that the longer limb bears a greater load and for a longer duration compared to the shorter limb. Also, the femoral head of the longer limb has less articulation with the acetabulum because of pelvic obliquity. Decreased surface area with the acetabulum, increased load and longer duration may contribute to osteoarthritis of the hip on the side of the longer limb.

Friberg found that sciatica occurred 78.5 percent of the time on the long leg side compared to 21.5 percent on the short leg side, and hip pain occurred 88.9 percent of the time on the long leg side compared to 11.1 percent on the short leg side (6).

Gurney et al (1), found LLI produces systemic effects of increased oxygen consumption and perceived exertion with a 2 cm artificial limb length discrepancy and significant increases in heart rate, ventilation, and quadriceps fatigue on the longer limb with 3 and 4 cm leg length discrepancies.

LLI Causes Low Back Pain

Numerous authors have implicated LLI as a contributing factor for low back pain (3, 8-13). Giles (3) found that the percentage of chronic low back pain patients with 10 mm or more LLI was 18.3 percent compared to 8 percent in a control group. Other conditions include knee dysfunction (14-16), aseptic loosening of hip prosthesis (17) and running injuries (18).

Numerous studies show LLI affecting gait, mostly, when the difference is greater than two centimeters (4). Song (5) found children compensating with limps and toe walking when LLI was 5.5 percent or more (approximately 3.5 cm deficiency in an average 13-year-old). More work is performed by the longer extremity and resulted in decreased walking velocity, 'stance time' and step length on the shorter side. Supination of the foot on the short leg side, pronation of the foot on the long leg side, the pelvis dropped inferiorly and the thorax shifted laterally to the short leg side. There was increased flexion of the knee (4) on the long leg side.

Measures

For your convenience, I created a list of brief opinions from various authors. Some authors report as little as 3 mm while others say more than 2 cm is clinically significant.

LLI	Comment (Author)
3 mm	Can cause injury to runners (Subotnick)
5 mm	Leads to biomechanical compensations in the spine (Friberg)
6 mm	Can cause injury to runners (Brody)
7 mm	Less than 7 mm rarely causes symptoms (Corrigan)
9 mm	Causes changes in the angle of lumbar facets (Giles)
10 mm	Contributes to the development of back pain (Cyriax)
15 mm	Can cause compensatory scoliosis (Gibson)
20 mm	Requires lower extremity compensation (Vogel)
22 mm	Causes significant scoliosis (Papaioannon)
40 mm	Often requires surgical correction (Ingram)

Clinical and Radiographic Observations

For musculoskeletal assessments, LLI evaluation is an important part of chiropractic neurologists' regimens. The clinician should suspect LLI when seeing a low ileum, laterality of the thorax while standing, abnormal gait, or an apparent leg length deficiency while the patient is prone or supine.

Radiographs are considered to be the "gold standard" of LLI assessment (7 – 11) and should be performed weight-bearing with the standard A-P lumbosacral view with its central ray at the level of the superior aspect femoral head, not its usual higher level. Substantial distortion will occur if the positioning is not correct. If the central ray is above the level of the top of the femur heads, radiographic distortion of axial rotation of the pelvis will cause the femur head that is further from the x-ray plate to project lower than the opposite side. This projection distortion can frequently make LLI greater or lesser than the actual deficiency and cause actual LLI appear nonexistent radiographically.

Dr. Saracino's Therapeutic Goals

I agree with the authors who place more importance on leveling the sacral base (vs. using orthotics) because the sacrum is the foundation the spine (12) and is critical for the spine ergonometrically to prevent lateral deviations.

I do not routinely radiograph the low back and prescribe heel lifts if the LLI is less than 7 mm, because the sacroiliac joints can compensate for much of the discrepancy. Manipulation, strengthening, stretching and appropriate physical therapy modalities should be employed to prevent the permanent use of assistive devises. Therapeutic goals include: primary- reduce pain; secondary- obtain sacroiliac mobility which allows for pelvic compensation; tertiary- (demonstrated in the rehab area of my office) strengthening and stretching for long-term self-care.

Heel / Sole / Shoe Lift Intervention

There are a number of observations that need to be made before implementing heel lifts or shoe lifts. Are the sacral obliquity greater than, less than, equal to, or opposite the side of the short leg? Sacral anomalies can frequently cause the LLI and sacral obliquity to not be proportional. Is the compensatory lumbar scoliosis convex on the short leg/low sacrum side? Anomalies of the sacrum and/or lumbar vertebrae (i.e.: wedged vertebrae) can sometimes result in the convexity toward the long leg/high sacrum side.

The following are suggested guidelines for the implementation of heel lifts and/or shoe lifts (12):

1. <u>I prefer full-sole leather inserts versus heel lifts</u>. Either should be used if up to 9 mm of height is required. For heel lifts, sorbothane inserts, made of a visco-elastic polymer found in running shoes, are best. These inserts should be added in increments of five mm per month so the pelvis had time to accommodate the new load and the onset of pain is minimized. For patients 16 – 65 years of age and three mm per month is the maximum.

2. More than 9 mm of height should be added to the outside the shoe with full-length sole and heel build-ons.

Some patients can report discomfort in the foot, ankle, knee, hip, or lower back within the first few weeks, so monitor patients closely.

Summary

LLI alters the biomechanics of and creates a number of pathological conditions for the spine and lower extremities. Chiropractic neurologists have always included LLI assessment in our physical examinations since our primary focus is on the neuromusculoskeletal system. Diagnosing LLI and its associated pelvic distortion can be successfully treated and long-term managed with the conservative measures we employ.

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