Leg Length Inequality and Analysis as Related to Thompson Terminal Point Technique: A Literature Review

By: Kristina Lehman

Faculty Advisor: Rodger Tepe, PhD

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ABSTRACT

Objective: This paper will proceed to answer how and why the Derefield-Thompson leg length analysis is valid while giving a special look to the interpretation of the analysis according to Thompson Technique.

Data Collection: A computer search using Pub Med and EBSCOhost generated articles relevant to leg length analysis, Thompson Technique, and leg length inequality.

Conclusions: The neurology behind leg length analysis and validity in regards to one indicator for an adjustment for a certain area has been proven to be sound. Chiropractic physicians can be confident in their analysis of a patient if they follow the proven methods.

Key Indexing Terms: leg length analysis, leg length inequality, chiropractic, Thompson Chiropractic Technique, drop technique, Thompson Terminal Point Technique, J. Clay Thompson.
INTRODUCTION

Leg length analysis has been at the center of the Thompson Terminal Point Technique since its development by J. Clay Thompson, D.C. in the 1950's. The debate of how, why, or if leg length analysis is valid is over. The explanations for what Clay observed many years ago are now common science. This paper will proceed to answer again the how and why the Derefield-Thompson leg length analysis is valid while giving a special look to the interpretation of the analysis according to Thompson Technique (1).

This paper will start with a brief history of Thompson Technique, then a short explanation of the Derefield Leg Length Analysis. Next terminology will be discussed; leg length inequalities (LLI) and the idea of short leg vs. contracted leg will be probed. What causes a short or contracted leg? A look at the physiology of a subluxation, including what structures in our body are most affected and how will all lead us to the topic of the neurology behind leg length analysis (LLA). The various spinal tracts involved with the Derefield-Thompson LLA will be discussed. Once the science and research behind LLA has been explored, this paper will touch on the interpretation of the LLA as it relates to Thompson Technique. This paper will finish with a look at the six basic categories of Thompson findings associated with LLA, and give descriptors of the subluxation patterns that are present with each.

In essence this paper strives to answer the following questions:

1. What is Thompson Technique?
2. What is Derefield Leg Length Analysis?
3. How does LLA work?

4. What causes a functional short leg?

This paper will only look at the analysis portion of Thompson Technique, and not delve into the correction or adjustment aspect of the technique. For that the reader is referred to the Thompson Technique Foundation and the Thompson Chiropractic Technique websites for ongoing seminars.

DISCUSSION

History of Thompson Technique:

Thompson Terminal Point Technique was developed by J. Clay Thompson, D.C. in the 1950's after a faulty headpiece on a table he owned became the "first drop piece". Dr. Thompson proceeded to repair the table. When his patients started to complain that the adjustments they were receiving were not doing as much good with the fixed table as before, he began to investigate. Thompson Terminal Point Technique is based on Newton's 1st law, which states that "A body is in equilibrium if no free force is acting upon it. If it is at rest, it remains so: If it is in motion, it persists in motion, unless an opposing force is met" (2).

In 1952 Dr. Thompson invented the first drop head piece and it was introduced at Palmer College's Homecoming the same year. Over the next five years he developed the
first complete drop system table; including drops for cervical, dorsal, lumbar and pelvic pieces (1).

**History of Derefield Leg Length Analysis:**

Dr. Romer Derefield of Michigan has long been given credit by Dr. Thompson as having done much of the initial research with leg length analysis. It was by chance one day that Dr. Thompson realized that head rotation could change a patient’s leg length (1, 2).

**Leg Length Inequality:**

**Terminology for LLI:**

Many terms have been used in the literature to refer to or describe a leg length inequality. Some terms are preferred by certain authors because they feel it more accurately depicts the problem causing a leg length inequality.

Other terms presented in the literature are leg length insufficiency, contracted leg, leg length discrepancy, leg length disparity, functional leg length inequality, acquired leg length inequality, apparent leg length inequality, and pelvic deficiency (1, 4, 10, 11).

All of these terms are referring to essentially the same phenomenon; a patient with no difference in actual leg length, but who shows one on a leg length analysis. They are all considered to be associated with pelvic obliquity, hypertonic muscles, and functional asymmetries of the sacroiliac joints (10).
Classifications of LLI:

There are two types of leg length inequalities; structural or anatomical and functional. Structural or anatomical leg length insufficiency denotes an actual bony asymmetry that exists somewhere in the kinetic chain between the calcaneus and femur (4). An anatomical short leg can also be called a true short leg since the leg remains short after any pelvic distortions have been corrected (4).

A functional leg length inequality can result from physiological responses to an alteration in biomechanics at any location along the previously mentioned kinetic chain. Examples of such alterations include pelvic distortions, soft tissue changes, aberrant foot mechanics, or compensatory spinal mechanisms (4). Thompson technique chooses to focus on the physiological responses to a subluxation, including the neuronal changes and response to the subluxation, as the basis of it’s rational for leg length analysis of a short leg (1, 2).

Validity of LLA:

Prone leg length analysis has not been successful in estimating standing LLI as measured by x-ray (10). One study by Shamburg demonstrated that a LLI could reliably be measured to within 3 mm by clinicians in a prone LLA. This study proved inter- and intra-observer reliability. It also showed an ability of the clinicians to reliably detect a change in leg length inequality with patient head rotation (3). Hestbaek concluded in 2000 after evaluating studies designed to demonstrate the validity of leg length analysis
that of the six studies evaluated, four validated prone LLA methods against radiographic measures (5, 15).

In a series of articles regarding Derefield-Thompson test for LLI and use thereof to demonstrate efficacy of an adjustment to the cervical spine (3, 18, 19, 20) inter and intra-observer reliability to measure LLI to within 3 mm was shown. However the studies showed that neither an adjustment nor sham treatment produced a significant change in LLI. The statistics and terminology within the study have been brought into question, reminding the reader that a consensus within our profession has still not been reached (3, 18, 19, 20). Another study along the same lines (9, 13) showed that leg length measurements by prone analysis are valid. According to Haas, evaluation of leg lengths in response to rotary pressure testing was overwhelmingly found to not be reliable for identifying vertebrae for an adjustment (23). All of these studies seem to mostly agree; leg length analysis is mostly reliable and reproducible for identifying a leg length inequality, but not valid for identifying specific subluxations. Clinical judgment and further testing seems to be indicated before performing an adjustment on your patient.

In ratings and reliability studies of chiropractic techniques to detect subluxations or treat low back conditions, prone leg length analysis was shown to not be very reliable in detection, but the associated Thompson style adjusting (prone HVLA with a drop assist) was rated very highly for the treatment of low back pain over other techniques (17, 25).
Effects of a leg length inequality:

Research has tried to examine how the presence of a short leg affects biomechanics. Various symptoms and conditions have been shown to occur with leg length inequality. Some of these conditions and symptoms are traction spurs, postural scoliosis, excessive foot pronation, predisposition for stress fractures, low back pain, hip pain, knee pain, ankle pain, foot pain, pelvic unleveling, sciatica, myofascial pain syndromes, iliotibial pain syndrome, trochanteric bursitis, and sacroiliac discomfort to name a few (4, 8, 12, 14, 16). The presence of these symptoms indicates a need for an effective treatment for a leg length inequality.

Physiology of a subluxation:

According to Thompson, the main reason a short leg appears with a subluxation is due to the neurological response of the muscle spindle, and the proprioceptive changes detected by the facet joints, intervertebral discs, and Golgi tendon organs. Discussion should now be directed towards the changes that occur with a subluxation.

Muscle Spindles:

A muscle spindle is comprised of both intrafusal and extrafusal muscle fibers. The role of an extrafusal fiber within the muscle spindle is to detect skeletal muscle contractions. The extrafusal muscle fibers are innervated by large myelinated axons called alpha motor neurons (22). As the extrafusal muscle fibers are stretched, as in a subluxation, the intrafusal fibers will detect this change (1).
Intramuscular muscle fibers are innervated by gamma motor neurons which play an important role in muscle tone. The intramuscular fibers are stimulated by a stretching or lengthening of the muscle, and respond by increasing tension within the muscle spindles preventing any further lengthening of the muscle which may result in damage (22). Intramuscular fibers are composed themselves by two types of nerve fibers. Nuclear bag fibers, also known as annulospiral endings, which detect dynamic or quick stretches; and nuclear chain fibers, also known as flower spray endings, which detect slow stretches (1).

Facet Joints:

The facet joints are involved with both proprioception and pain sensation. According to Thompson, subluxation causes a distortion of the facet joint thus putting stresses on the facet capsule. The proprioceptive aspect, or joint position sense, of the facet is carried to the brain in two different ways. Conscious joint position sense is carried in the dorsal columns to the brain. Most joint position sense information is used for postural controls. This information is carried by the dorsal and ventral spinocerebellar tracts to the cerebellum (24).

Golgi tendon organs:

Golgi tendon organs are influenced by increases in tension within the tendons of muscles which helps in the contraction of voluntary muscles. Golgi tendon organs are actually the nerve endings of fibers which are of the Ib afferent system. The Ib afferent fibers work to decrease the contraction of their own muscles by inhibiting the alpha motor neurons that supply the muscles (22). In regards to a subluxation, the Golgi tendon
organs detect the changes in tension within the tendons due to distortions in the connecting musculature. This results in the Golgi tendon organ to be stimulated (1).

**Intervertebral Discs:**

The proprioceptive receptors in the fibrocartilage of a disc are stimulated by the distortions in the disc which are a result of a subluxation. This stimulation of the proprioceptive receptors is interpreted as aberrant spinal mechanics (1).

**Neurology behind LLA:**

The alterations to each of the above structures are detected by large, myelinated type 1a afferent fibers. The aberrant proprioceptive information travels via the dorsal and ventral spinocerebellar tracts to the cerebellum. The cerebellum is responsible for two main functions, motor coordination and all proprioception. The cerebellum is responsible for monitoring what is occurring within the body at any given point in time. The cerebellum processes the information coming from the dorsal and ventral spinocerebellar tracts and then sends it to the thalamus. The thalamus is now responsible for carrying this sensory information to the cerebral cortex which monitors what should be happening in the body (1, 2, 6, 7, 22, 24).

If the information in the cerebellum is different from what the cerebral cortex expects to be happening, then a corrective response command is given in the cortex. This corrective information is delivered to the body via four descending efferent tracts. These four tracts are not capable of firing on their own, but must fire in unison. The four tracts
are the tectospinal, rubrospinal, reticulospinal, and vestibulospinal tracts. Each is reviewed below (1, 2, 6, 7, 22, 24).

**Tectospinal tract:**

The tectospinal tract is responsible for head and eye movement as a result of a sight or sound stimulus (1, 2, 6, 7, 22, 24).

**Rubrospinal tract:**

The rubrospinal tract carries information from the red nucleus along with the rubrobulbar tract. The red nucleus facilitates flexor movements in the contra lateral upper limb via the rubrospinal tract directly and indirectly via the rubrobulbar tract. Ultimately the rubrospinal tract has a strong influence on proximal and distal muscles of the limbs, and is always involved with motor coordination (1, 2, 6, 7, 22, 24).

**Reticulospinal tract:**

The reticulospinal tract originates from the medullary reticular formation and the pontine reticular formation. The reticulospinal neurons are influenced directly by the cerebral cortex via the corticoreticular fibers. They are also influenced by the cerebellum, vestibular nuclei, and ascending pain fibers from the spinal cord. The medial reticulospinal fibers mainly exert their influence on the movement of axial muscles by inhibiting flexor movements and facilitating the extensor movements. The lateral reticulospinal fibers inhibit extensor movements and facilitate flexor movements while strongly influencing the muscles of the limbs (1, 2, 6, 7, 22, 24).
**Vestibulospinal tract:**

The vestibulospinal tract in the most important spinal tract in regards to leg length analysis. The vestibulospinal tract is always excitatory, and firing of this tract results in muscle contractions. This tract supplies postural muscles which are primarily located in the low back and pelvic region (1, 2, 6, 7, 22, 24).

The medial vestibulospinal fibers are involved with bilateral axial movements associated with posture. Since postural adjustments of the vertebral column require bilateral muscular activity at multiple levels, intersegmental communication via interneurons is necessary (1, 2, 6, 7, 22, 24).

The lateral vestibulospinal fibers are chiefly involved with movements of the proximal and distal muscles of the limbs. Since these movements are mainly unilateral and may be limited to one limb, intersegmental connections are not as necessary. Instead of being influenced by interneurons, intermediate propriospinal neurons are utilized (1, 2, 6, 7, 22, 24).

**What causes a short leg:**

There is a concept called “gamma gain” associated with the vestibulospinal tracts. This refers to the actions caused by the innervation of a muscle by the vestibulospinal tract fibers. When a synapse occurs at this innervation, the intrafusal muscle fibers lengthen which in turn causes a neurological contraction of the extrafusal muscle fibers.
It is this contraction that leads to a short or contracted leg in leg length analysis (1, 2, 6, 7, 22, 24).

**Interpretation of LLA according to Thompson:**

According to the Thompson technique due to the neurology explained above a doctor is able to analyze a patient through leg length analysis and identify which areas of the spine are to be corrected. The Thompson technique utilizes a terminal point table to take advantage of Newton’s 1st Law to deliver a low force, high velocity adjustment to the patient. The terminal point table is set according to the patient’s body weight, and area to be adjusted, then adjusted to allow a drop technique force to be utilized (1, 2, 7, 21).

Thompson uses leg length analysis along with active or passive patient movements to identify the primary areas of subluxation. There are many possible subluxations that can be identified with Thompson; a few will be reviewed here.

When you approach the patient who is in a prone position on the table, with legs extended and head neutral there are three possible findings you may observe. Either the patient has a left short leg, right short leg, or even legs. If the patient presents with even legs, they fall into one of 3 categories, labeled 1-3 in the following table. If the patient presents with a short leg, they fall into one of the other 3 basic categories, labeled 4-6 in the table (1, 2, 7, 21).
Six Basic Categories with LLA and Thompson:

2. Bilateral Cervical Syndrome  5. Negative Derefield
3. X-Derefield                 6. Positive Derefield

To determine which category the patient truly falls into further testing is done. The patient is first asked to rotate their head to the left and right while the doctor observes their feet for any changes in leg length. If the patient rotates their head to the right and left and no changes are observed, the legs are then brought into flexion. The patient is then asked to repeat the head rotation. If still no changes are observed, the patient is labeled as Normal for that visit. If in flexion a short leg is observed, and it changes with head rotation the patient is classified as having an X-Derefield. If when in the extended position leg length changes are noted such as a short leg appearing on the side of head rotation, the patient is said to have an occipital problem and is classified as a Bilateral Cervical Syndrome (1, 2, 7, 21).

If the patient presents with a short leg in extension, the patient is directed to rotate their head left and right. If in rotation to one side the doctor observes the short leg to lengthen thus appearing as even legs, the patient is considered to have a cervical subluxation and is classified as a Right/Left Cervical Syndrome. The cervical syndrome is named by the side of head rotation that corrected the short leg, but is a misnomer since the side said to be subluxated is the opposite side and thus the adjustment is to be made there. If no changes in leg length are observed in head rotation, the legs are taken into a flexed position. If in flexion the short leg becomes shorter, it is a Negative Derefield. If
they become even or the sort leg appears longer than the other leg, it is a Positive Derefield. The Derefield classifications refer to specific pelvic subluxation patterns (1, 2, 7, 21).

CONCLUSION

In my opinion leg length analysis associated with a functional short leg has been shown to be scientifically sound and reliable. The literature has shown that leg length analysis is a reproducible means of analysis. Leg length analysis can never show a doctor where to adjust, that is where clinical thinking as well as palpation and orthopedic tests come in. I believe leg length analysis to be a valid method to systematically identify which region on a patient is to be addressed first or is the area of greatest aberrant neurological stimuli. In general, having a systematic method to approach patients’ problems will result in a greater degree of consistent care for the patient and reproducible examinations and findings.
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