CT Scanography for Limb Length Determination

Kevin J. O'Connor, DPM, John F. Grady, DPM,† and Michael Hollander, DPM‡*

Clinical measurement of limb length is taken from the superior aspect of the anterior superior iliac spine (ASIS) to the distal aspect of the medial malleolus using a tape measure. This measurement is best employed as an initial clinical assessment but is not to be used as a definitive measure. The ASIS can be difficult to palpate in obese or muscular patients. Also, soft-tissue contractures in the hip or leg and differences in muscle size of the two extremities may make this measurement inaccurate. When a tape measure is used, a decrease in leg length may be produced by genu valgum and an increase in leg length may be produced by genu varum.[8] Many authors have stated that clinical measurement is inaccurate and often misleading. Eicher[4] found the degree of accuracy with a tape measure to be ± 0.5 cm. Beal[2] states that differences of 0.5 inch or less with tape measurement may be assumed to be unreliable. Clarke's[3] study showed that two experienced examiners using a tape measure from the ASIS to the medial malleolus came within 5 mm of each other's measurement in only 20 of 50 cases. If a limb length inequality is to be accommodated, a more quantitative measurement is needed.

Another clinical measurement for limb length inequality involves palpation of the iliac crests. Examiners attempt to estimate the degree of asymmetry to the nearest 5 mm.[4] In a study conducted by Clarke , two examiners using this method were

* Former Research Fellow, Department of Orthopedic Sciences, Dr. William M. Scholl College of Podiatric Medicine, Chicago, Illinois; Currently in private practice, Chicago, Illinois

† Diplomate, American Board of Podiatric Surgery; Fellow, American College of Foot Surgeons; and Director, Sports Medicine Center, Dr. William M. Scholl College of Podiatric Medicine, Chicago, Illinois

‡ Diplomate, American Board of Podiatric Surgery; and Clinical Associate Professor, Dr. William M. Scholl College of Podiatric Medicine, Chicago, Illinois

correct within 5 mm of the radiographic results in only 16 of 50 cases.

Various radiographic techniques have been employed for limb length measurement. Teleradiography involves a single exposure on one large film. This technique demonstrates the relative length of the two limbs. Vogel[8] states that poor magnification and inconsistent radiolucency with this technique result in undependable results. Scanography uses a long exposure from a moving tube, collimated by a lead diaphragm to a narrow-slit glass beam.[5] Although this technique is accurate, Aitken and colleagues[1] state that it involves a long exposure time, a high radiation dose, and considerable wear on the radiographic tube. The radiographic technique most frequently employed is orthoroentgenography. The patient lies supine on a special frame, on which a metal rule is placed between the legs. Three successive exposures are centered over the hips, knees, and ankles.[8] Each femur and tibia are then measured by extending a right angle from the ruler to the bony site to be measured.[7] This technique requires precise centering of the ruler. Aitken[1] and colleagues state that axial decentering results in inaccurate measurements. Another problem with this technique is excessive radiation exposure. Gofton and Trueman[6] cite movement of the legs between exposures and inaccurate positioning as major sources of error. Also, Glass and Poznanski[5] report that examination gives information in only one plane and does not permit determination of flexion of the limb, which will result in erroneous shortening.

CT SCANNER

A new method of determining limb length discrepancy is computed tomography (CT) scanograms (Figs. 1 to 6). The patient lies supine on the CT scanner table with both legs in full extension.[5] Two frontal views are obtained—one of the femur and one of the tibia.[5] Cursors, or markers, are then placed over each femur at the most superior aspect and at each medial femoral condyle distally.[7] The cursor is then placed over the medial tibial plateau and the tibial plafond. Measurements of the femur and tibia are then calculated by the computer and repeated three times for each extremity and averaged.[7] The length of this procedure averages 10 to 15 minutes. A lateral view of the lower extremity is also indicated on the basis of studies conducted by Glass and Poznanski.[5] They determined that flexion at the knee will result in an apparent shortening of the tibia. Very little, if

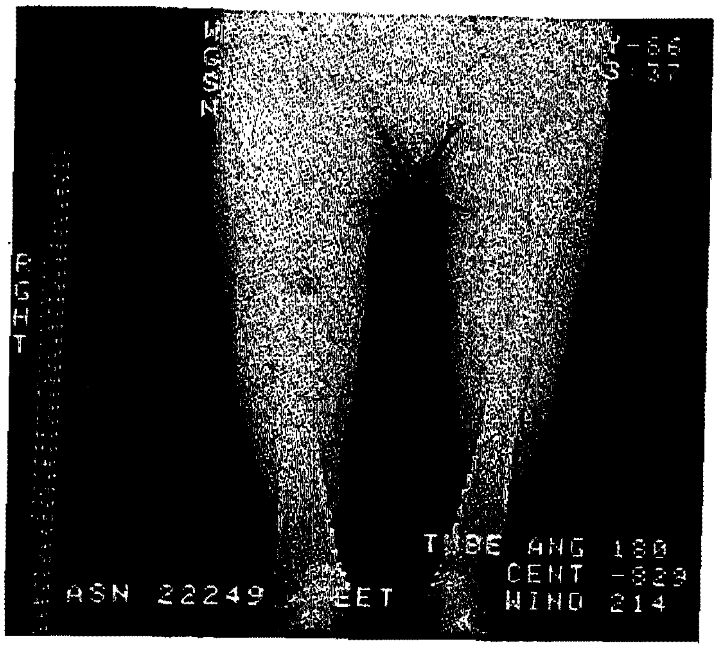


Figure 1. Section of CT scanogram showing cursor placement and scale for measurement of right femoral segment.

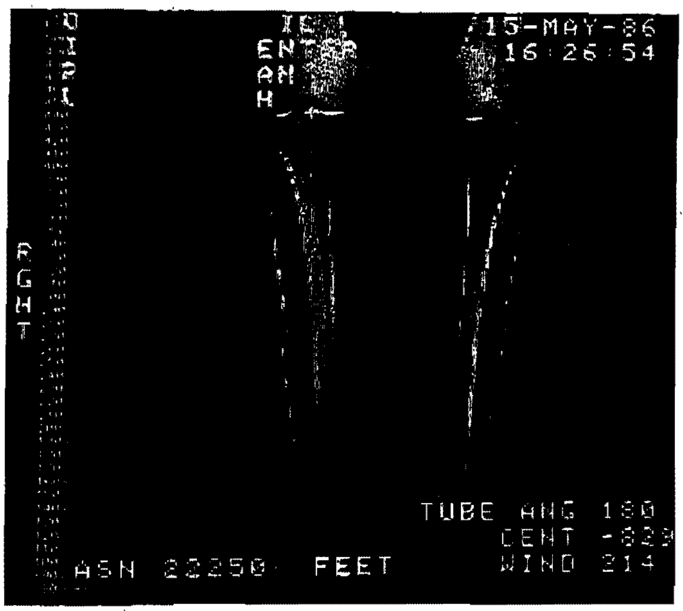


Figure 2. Section of CT scanogram showing cursor placement and scale for measurement of right knee segment.

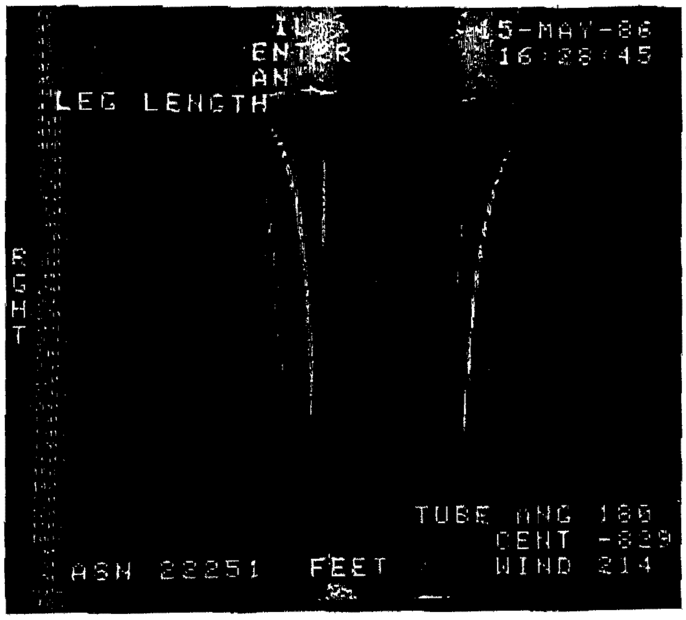


Figure 3. Section of CT scanogram showing cursor placement and scale for measurement of right tibial segment.

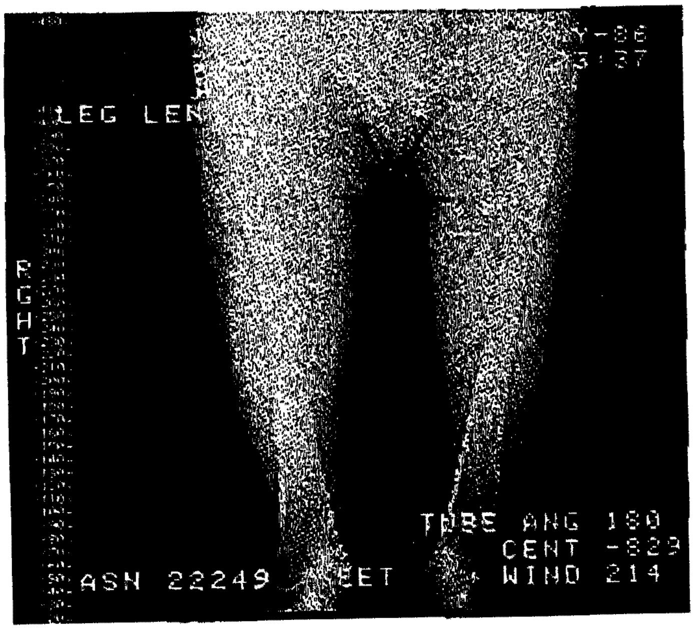


Figure 4. Section of CT scanogram showing cursor placement and scale for measurement of left femoral segment.

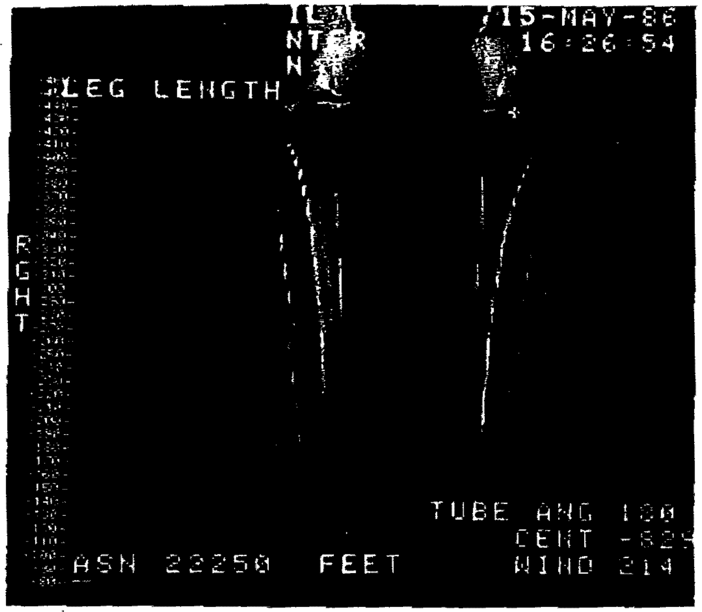


Figure 5. Section of CT scanogram showing cursor placement and scale for measurement of left knee segment.

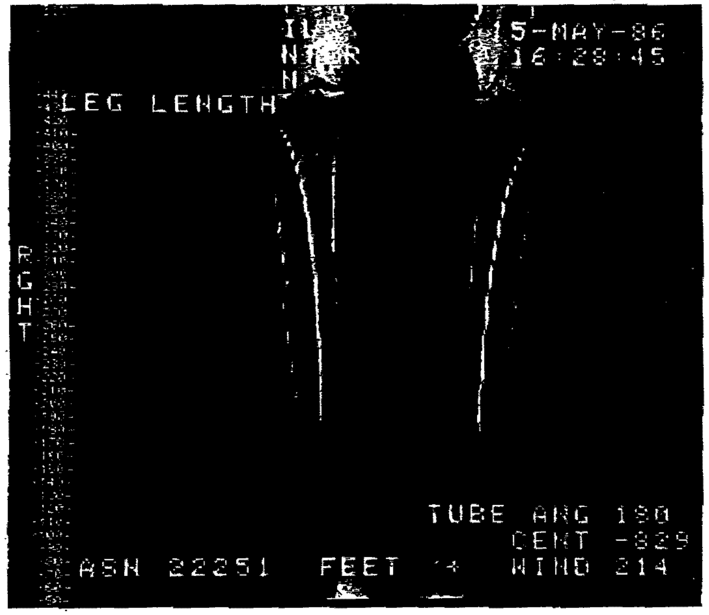
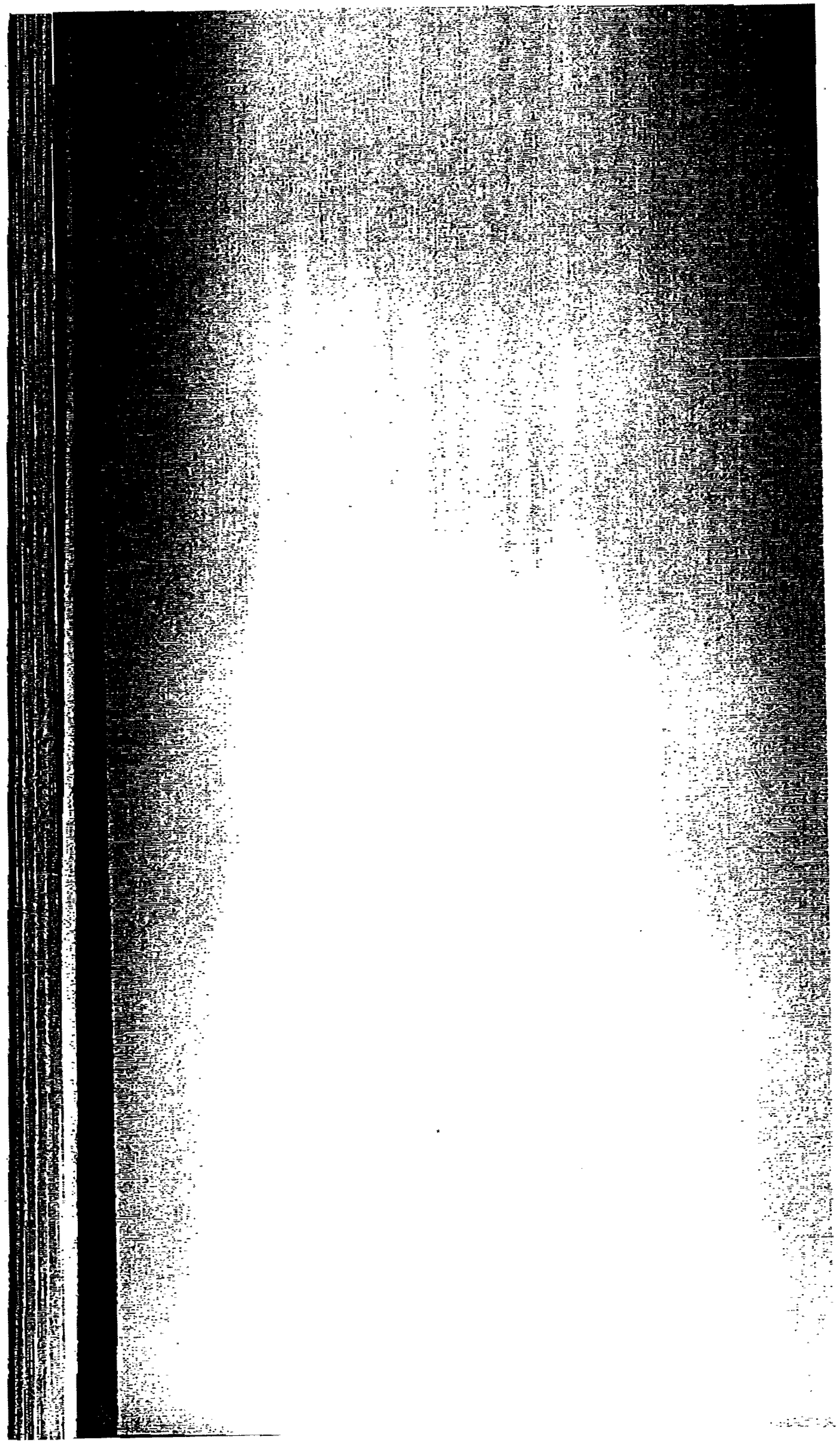


Figure 6. Section of CT scanogram showing cursor placement and scale for measurement of left tibial segment.



any, change in femoral length occurs. They suggested that the knees be held in place with Velcro straps. There are many advantages of using CT scanograms for limb length measurements. The measurements are more precise and accurate, the cost is compatible with conventional techniques, less time is required, and, most important, Aitken and colleagues[1] showed that the radiation dose is 3 to 6 times less than that from the conventional technique.

CASE I

On February 14, 1986, a 28-year-old white female presented to the Sports Medicine Clinic at the William M. Scholl College of Podiatric Medicine. She reported a 3- to 4-year history of low back pain that occurred a day or two after running. The symptoms were now present after walking. The patient, a professional photographer, carried her heavy equipment on shoulder straps. She had not been running for the past year because of the back pain. The patient received previous treatments from other doctors that consisted of oral antiinflammatory drugs, muscle relaxants, ice, physical therapy, and leg lifts, which gave her only temporary relief.

Her medical history was unremarkable except for a complaint of "psoriatic lesions" and her back pain. Examination revealed pain on palpation in the lumbosacral area on both sides of the spinal column. The patient's right shoulder and right side of the pelvis appeared lower than the left ones in both stance and gait. Her knees were internally rotated in stance and gait, and her malleolar position was external bilaterally. The left limb was 0.5 cm longer than the right limb by measurement of ASIS to ipsilateral medial malleolus. Subtalar neutral was 2 degrees varus bilaterally and forefoot neutral was 2 degrees valgus bilaterally. Her feet were mildly pronated in stance.

Initial treatment consisted of a low-dye strapping with a metatarsal longitudinal pad bilaterally, and an eighth-inch heel lift was added to her right shoe. When the patient returned 1 week later, she related an 80 per cent improvement in her back symptoms. She was scheduled for a CT scanogram to evaluate limb length to verify the difference. The scanogram revealed a 0.5-cm difference, with the left limb being longer. A 5-mm heel lift was added to her right orthosis. The patient has remained comfortable, even on a vacation during which she hiked 4 or more miles per day and carried a backpack and a tent.

In this case, the CT scanogram was used to quantitate the limb length difference to determine the exact height of heel lift that was needed.

CASE II

On August 14, 1986, a 36-year-old male handball player presented with a chief complaint of pain in the right knee. The pain had a gradual onset and had worsened with time. In his unsuccessful quest for relief, he had been to two orthopedic surgeons as well as to his family physician. The pain had been present for 4 months.

On physical examination, some crepitus was noted in his right knee on active extension, and the patient had a positive Clark's test. Synovial effusion was palpable and obvious. Diagnosis of the patellofemoral compression syndrome was made on the right side. Limb length was measured from the ASIS to the medial malleolus, demonstrating the limb to be 0.5 inch longer on the right side.

Foot examination revealed a right partially compensated rearfoot varus deformity that was symmetric right to left. Before his rearfoot varus deformity could be accommodated, a CT scanogram was obtained. This was also used to further assess his limb length inequality.

The scanogram revealed that the right limb length was 93.9 cm and the left 92.6 cm, a difference of 1.3 cm.

On the following visit he was given a quarter-inch heel lift to accommodate the limb length inequality. The patient returned in 2 weeks and stated that his knee was "75 per cent." He was prescribed a quarter-inch lift to the heel and sole of his right shoe. After 1 month of therapy, he was pain free, despite returning to full activity with handball. He was still pain free with lift therapy only as of March 19, 1987.

This example illustrates that many of the so-called overuse syndromes can be related to the added pressure on a long limb. It also demonstrates the need for greater accuracy than that obtained with clinical measurement, and the CT scanogram seems to be the answer.

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John F. Grady, DPM
Sports Medicine Center
Dr. William M. Scholl College of Podiatric Medicine
1001 North Dearborn Street
Chicago, IL 60610