Gait Analysis and Motor Point Block in Dynamic Varus of the Rear Foot in a Head Injured Adult

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This clinical note describes a typical case of dynamic varus deformity of the hind part of the foot in a head injured adult. Gait analysis objectified, by kinematic data, the perturbed movement of the rear foot in the frontal plane and identified, by dynamic electromyography, the overactive muscles (posterior tibialis) involved in the deformity. The diagnosis was confirmed by a motor point block of the posterior tibialis muscle with functional improvement. Kinematic data also showed improvement after the block. This case report illustrates the usefulness of gait analysis in diagnosis and management of gait disturbances in adult patients.

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THE VALIDITY of gait analysis for therapeutic decision making has recently become a matter of debate in editorials. Gage, for instance, pleads for the usefulness of the gait laboratory in treatment of cerebral palsy. He states that clinical gait analysis provides detailed and objective data about the gait pattern and muscle activity. It allows guidance for treatment (surgery, orthotics, etc) and assessment of outcome. Watts, however, questions the validity of gait analysis; he states that it underscores the functional outcome by focusing on the mechanical aspects, there is no randomized prospective study comparing the decisions made by the clinician and decisions from the gait laboratory, and the cost of equipment and qualified staff is high. Watts considers gait analysis as a research tool not to be used to make preoperative decisions, except for changes measured after motor nerve block.

The purpose of this report is threefold: (1) to measure movements of the rear foot in the frontal plane applying Nigg’s model; (2) to confirm the diagnosis and orient the treatment of a dynamic varus by gait analysis in conjunction with a motor point block; and (3) to illustrate the usefulness of gait analysis with an intricate case of gait disturbance in an adult head injured patient.

CASE REPORT

A 21-year-old farmer was involved in a motor vehicle accident. He presented with a traumatic brain injury with a right hemiparesis and multiple fractures (right femur and talus and left os cuboideum, second and third ossa metatarsalia, corpus mandibulae and sinus maxillae). Computed tomography (CT) of the brain showed only a right peripheral occipital hypodensity without cranial fracture or hematoma. The patient also had a bilateral compression injury of sciatic popliteal nerves.

After two years of intense rehabilitation, he recovered functional independence with a maximal functional independence measure (FIM), and returned to work. A painful varus of the right foot persisted, however, interfering with his work. Because the varus was reducible, a functional imbalance between invertor and evertor muscles was suspected. To test this diagnostic hypothesis, a gait analysis, focused on the right leg, was performed.

The patient walked barefoot at self-selected speed (1.25m/sec ± 0.07), on a walkway 6m long. Pressure-soles taped under his feet determined the gait cycle interval and foot support patterns. The cycle began and ended with right initial contact. The data were normalized as a percentage of the gait cycle.

The kinematic data were collected by Elite System 5.0, based on 4 infrared cameras that measured the coordinates of passive markers at 50Hz. The coordinates were smoothed by the Elite System 5.0 software program. The movements of the right foot and ankle in the sagittal plane were determined using the classical 2-segmental model. In the frontal plane, the foot segment was described by 2 markers positioned at the rear part of calcaneus on the longitudinal axis. Similarly the leg segment was determined by 2 markers taped on Achilles tendon (fig 1).

By convention, the positive angle between the two segments represents varus, and negative value valgus.

Myoelectric activity of the anterior tibialis, gastrocnemius and peronei were recorded with small surface electrodes; for the posterior tibialis muscle indwelling paired electrodes were used. The electromyogram (EMG) was recorded with telemetry system (Teleng BTS). The signal was digitalized at 1,000cps and filtered (band-pass 25 to 300Hz). The onset and cessation of muscle activity was determined by computing the threshold voltage of EMG as described by Van Boxtel and colleagues.

The kinematic data are shown in figure 1. Angular displacement of ankle in sagittal plane was normal and non-illustrated. In the frontal plane, however, angular displacement was severely disturbed. At initial contact, the rear foot was at 6° ± 4.6° of varus. Afterwards, it inverted without attaining the neutral position. In the last 10% of the stance phase, it inverted exaggeratedly to 17° ± 2.8°. Hence, the foot was continuously positioned in excessive varus.

The timing of the EMG is shown in figure 2. The activation patterns of triceps surae, peronei and anterior tibialis were normal. The posterior tibialis showed nearly continuous activity. This result suggests that overactivity of the posterior tibialis was responsible for the dynamic varus deformity. After informed consent of patient was obtained, a motor point block of this muscle was performed as diagnostic test.

To infiltrate the posterior tibialis muscle as closely as possible to his motor point, a pole needle was inserted via an anterior approach at the junction of the proximal quarter and distal three-quarters of the leg. Under radioscopic control, the needle was...
moved forward through the interosseous membrane as closely as possible to the medial edge of the tibia. Correct positioning of the needle was checked by electric stimulation and by injecting a small volume of contrast medium. Then, a mixture of 3mL 90% alcohol and 3mL marcaine was injected in several steps of 1 to 2mL. The needle position was slightly changed between each step.

One week later the patient was reevaluated. His foot was less supinated and caused less pain while he was working. A second gait analysis was performed, but without EMG recordings, since the purpose of motor point block is only to weaken the muscle and EMG does not give reliable information on muscle force in dynamic condition.

The changes in angular displacement of the rear foot in the frontal plane are shown in figure 1. At initial contact, the varus was reduced from 6° ± 4.7° to 0° ± 0.7°. During the midstance the foot was nearly in neutral position. The varus movement at the end of the stance phase was reduced attaining only 8° ± 0.1°. After injection, the foot was always less positioned in varus than before. The angular displacement of the rear foot was near normal.5

**DISCUSSION**

This case is typical of dynamic varus deformities of the hind part of the foot in spastic diseases such as stroke, head injury, anoxic brain damage, or cerebral palsy. When diminished sensation, vestibular dysfunction, impaired cognition, or some other interfering factor are excluded, the problem may be attributed to abnormal muscle tone. In case of varus, it is generally from inappropriate timing of ankle extrinsic muscles. In the absence of recovery after a sufficient delay (18 months for head injury) and in case of nonoperative treatment failure, the patient may be selected for surgery. Determining the pattern of muscle activity by EMG permits an operating plan to be proposed: (1) if the posterior tibialis muscle is active in swing phase exclusively (reverse-phase action), its tendon is transferred anteriorly to the dorsum of the foot; (2) if the posterior tibialis muscle is overactive, it is released or lengthened; (3) if the anterior tibialis muscle is overactive a split tendon transfer is realized with half of the tendon transferred to the cuboid bone.

Even with gait analysis, it is difficult to obtain predictable results of surgical or nonsurgical treatments because they are only directed toward the peripheral manifestations of a predominantly central disorder. These manifestations may vary with time and—in children—with growth. Therefore, we think that a therapeutic test such as motor point block or nerve block can help in case of dynamic deformities with limited contractures. By simulating the weakening of a surgical release, this test can, by means of kinematic data from the gait analysis, forecast the outcome of surgery. It has fast onset and little side effects, and is lightly invasive, always reversible, and inexpensive. It also leads to significant therapeutic benefits. During the period of reduced spasticity, a better control of movement facilitates growth, thereby reducing the incidence or degree of fixed contractures.

This report illustrates the ability of gait analysis to objectify dynamic deformities by kinematic data in a head injured adult, and to identify by dynamic EMG the involved muscle(s). Moreover, it shows that gait analysis is sufficiently sensitive to detect kinematic modifications after a single motor point block.

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Suppliers
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