Computerised Gait Analysis

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Introduction

Computerised gait analysis (CGA) is a systematic evaluation of locomotion by which gait characteristics are measured, abnormalities identified, causes suggested and treatments formulated. It is not intended to replace clinical examinations, but as an adjunct to understand the impairment better. The treatment decision should be made in full consideration of the patient’s condition, physical examination and medical history.

Clinical use of computerised gait analysis

To date, CGA has its greatest clinical value as a test for individuals with central nervous disorders associated with spasticity, especially children with cerebral palsy (CP). To increase mobility and prevent deformity, various medications, non-surgical therapy regimens, bracing, assistive devices, and/or orthopaedic and neurosurgical procedures are prescribed for these children. In the past, many orthopaedic procedures were performed separately during a child’s growing years. But it is far more desirable to perform multiple orthopaedic procedures at a single surgical session. This approach avoids the psychological impact of multiple separate procedures, optimises functional improvement by using a single operation, and reduces the medical costs. CGA offers objective measurements not provided by clinical examinations and helps clinicians to select the most appropriate procedure.

Many prospective and retrospective studies were published regarding the utilisation of CGA in clinical decisions for children and adolescents with cerebral palsy. These studies demonstrated that CGA plays a role both in confirming or refuting indications for surgery or in delaying it.

Wren et al compared the clinical course of a group of 313 children who had undergone CGA with another non-CGA group of 149 children. After adjusting for differences in age and severity of functional problems, it was found that the CGA group had more distinct procedures during the initial surgery than the non-CGA group. Only 11% of the CGA group children needed additional surgery in contrast to 32% of the non-CGA group.

Role of CGA in NT West Cluster*

Centre of Gait and Motion Analysis at Tuen Mun Hospital provides a full spectrum of gait and motion analysis services including physical examination, video records, temporal-distance data, three dimensional joint kinematics and kinetics results, electromyography data, balance ability and metabolic energy expenditure, to patients suffering from a variety of diseases.

Physical Examination

Measurements are made of the patient at rest. They include passive joint range of motion, joint contracture, muscle strength and tone, bony deformity and neurological assessment. This information is then correlated with the CGA data to help determine the potential causes of the gait deviations.

Video Records

Specialised computer-interfaced video cameras measure patient motion. An initial video clip provides qualitative documentation of how a patient walks. Close-up views of a specific motion and recording in slow motion allow the observer to evaluate the walking pattern. For example, close-up views of the feet provide a means to evaluate hind foot position and motion.

Figure 1. Physiotherapist measures the passive range of motion

Figure 2. Close-up view shows the foot position and motion.
Temporal-distance Data
We look at velocity, cadence, stride length, step length and percentage of stance/swing. These measurements of functional level allow comparison with subsequent progress.

3D Joint Kinematics
Markers with retro-reflective surface are placed on the patient’s skin, aligning with specific bony landmarks and joints. (Fig 3) As the patient walks along a straight pathway in the laboratory, infrared beams reflected from these markers are tracked by eight high-speed cameras, all interfaced with a central computer to generate 3D motions trajectories of these markers. Computation of the marker position data gives us the angular orientation of particular body segments as well as the angles between segments (joint angles). (Fig 4)

3D Joint Kinetics
Multicomponent force platforms imbedded in the walkway provide measurement of reaction between the foot and the ground as the patient walks over them. (Fig 5) The mechanics of walking can thus be further analysed. The data can be assessed directly or used to calculate the load in and across the joints. We can then tell how much load each joint is producing while the patient walks (joint moments and joint powers). (Fig 6)

Electromyography
Wireless electrodes placed on the surface of specific muscles give us dynamic electromyography (EMG). (Fig 7) This technique measures the electrical potential generated by the muscle when it is activated. It discerns whether the muscles are contracting in a concerted manner to produce the required forces, if the timing of these contractions is appropriate or do the muscles need to be strengthened or are some pulling too hard because of spasticity. This information can be used with joint kinematics and kinetics results to understand better the subject’s neuromuscular abnormalities. (Fig 8)

Balance Ability
Loss of coordination or balance is often observed in patients with neurological disease. The severity of this deficit at presentation and after treatment is often subjective. Advanced biomechanical technology equipped in our Centre provides quantitative data to complement standard clinical assessment. The force platform detects changes of postural sway by assessing the ground-reaction forces. (Fig 9) These ground-reaction forces are used to calculate the centre of pressure (COP). Maximum COP displacements in anterior-posterior and mediolateral direction can be used to quantify postural instability.
Energy Expenditure

Energy consumption during walking provides an estimate of the overall ambulatory status of the patient. (Fig 10) Patients with movement disorders spend more energy in walking. Oxygen consumption is therefore a good measurement of the severity of such disability and can be used to gauge subsequent improvement after treatment.

**Figure 10. A small breathing mask is worn to measure the oxygen consumption.**

An interdisciplinary team composed of neurosurgeons, orthopaedic surgeons, neurologists, physiotherapists and bioengineers will then review all these data and formulate a treatment recommendation (Fig. 11) consisting of a combination of physiotherapy, medications, bracing and surgery.

In summary, computerized gait analysis is vital for the evaluation of pathological gait in a more objective fashion. Its beauty lies in the integration of many different analyses to arrive at a comprehensive assessment of gait pattern.

*NT West Cluster consists of Tuen Mun Hospital, Pok Oi Hospital and Castle Peak Hospital under the Hospital Authority*

### References


