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Addepalli Santhosh, Hloba N.S., Hloba A.A.*

ROLE OF GAIT ANALYSIS IN DIAGNOSTICS OF NEUROLOGICAL DISEASES

Kharkiv National Medical University, Kharkiv, Ukraine
*Ukrainian Scientific Research Institution of Prosthetics and Rehabilitation, Kharkiv, Ukraine
santhosh29.addepalli@gmail.com

Background. Gait is the systematic, rhythmic, coordinated, semi-rotatory movements of the lower limb, trunk, arm and head resulting in an interplay between loss and recovery of balance with constant change in the center of gravity causing forward propulsion of an organism in space. Normal gait is rhythmic and characterized by alternating propulsive and retropulsive motions of lower extremities; however, locomotor or neurological disorders cam lead to appearance of specific gait patterns. Data on walking can be used to evaluate the effects of treatment, such as surgery, drugs, and/or assistive devices, on patients having gait pathologies or be a tool for long-term clinical monitoring of surgical patients (e.g., for patients who have received total artificial knees). Moreover, gait analysis can be used as a diagnostic tool for patients having musculoskeletal and/or neurological control problems and serve as an indicator of disease severity in such patients.

Normal gait is rhythmic and characterized by alternating propulsive and retropulsive motions of lower extremities. Gait includes 2 main phases – stance phase and swing phase. Stance phase begins at the instant that one extremity contacts the ground and continuous only as long as some portion of the foot is in contact with the ground. It is approximately 60 % of gait duration. Swing phase begins as soon as the toe of one extremity leaves the ground & ceases just before heel strike or contact of the same extremity. It makes up 40 % of normal gait cycle.

Main methods of gait analysis comprise stride analysis, angular kinematic analysis, force plate and foot pressure analysis, and electromyographic (EMG) analysis. In stride analysis, the temporal sequence of stance and swing are qualified using either simple tools, such as a stopwatch and ink and paper, or electromechanical instruments, such as pressure-sensitive switches imbedded in shoe inserts or applied to the bottom of the foot. Angular kinematic analysis uses electrogoniometry, accelerometry, and optoelectronic techniques. Electrogoniometers are available in uniaxial and multiaxial configurations and are attached directly to the body segments of interest for the direct measurement of an angular displacement. Force plate and foot pressure analysis techniques involve the recording of information at the foot- floor interface during the stance phase of gait. Force plate measure the resultant ground reaction force beneath the foot and the location of its point of application in the plane of the supporting surface. Pressure plates or insoles measure the load distribution beneath the foot during stance. EMG is used to record muscle activation during walking. Both surface and intramuscular sensing techniques are used in gait analysis. It helps to explain motor performance underlying the kinematic and kinetic characteristics of gait.

Deviations of gait can occur due to pain, weak muscle, abnormal muscle activity, joint abnormalities, contractures around joints, limb length discrepancies etc., in some cases causing appearance of specific gait patterns that can be used in diagnostics of particular diseases and their severity.

In the early stages of idiopathic Parkinson's disease, gait is characterized mainly by reduced speed and decreased amplitude of leg movements, accompanied by reduced arm swing. Falls and complex gait disturbances such as freezing and start hesitation are usually confined to the later stages of Parkinson's disease. Flex posture of neck, trunk hip and knee occurs due to rigidity; specific are short steps lacking heel strike and toe off, loss of arm swing and pelvic rotation.

In cerebellar disease, gait is slow and wide-based, with irregular timing and amplitude of steps. Sway can be omnidirectional in lesions of the vestibulocerebellum, lateralized in hemispheral lesions and predominantly anteroposterior in atrophy of the anterior lobe. Apart from disequilibrium, a disturbance of trunk and limb kinematics and interlimb co-ordination is presumed to be responsible for gait disturbance.

Conclusion. Gait is a natural movement for human body, however, in reality it is the thoroughly coordinated complex of various movements of different body parts. Therefore, damage on any of its components will cause changes of gait patterns that helps in diagnostics and treatment assessment of a number of diseases. Stages of Parkinson’s disease are characterized by different changes of gait, thus the diagnosis can be more precise while using gait analysis. For cerebellar lesions, gait research helps to estimate the site of lesion more precisely. Analysis of gait is not a new method, however, its value as a diagnostic instrument is really high, thus, it’s necessary to continue its research and to improve methods used for that purpose.

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Amara Taha Morad, Isaeva I.N.

FUNCTION AND DYSFUNCTION OF BARORECEPTORS

Kharkiv National Medical University, Kharkiv
Scientific Supervisor: PhD Inna N. Isaeva
inisaeva@ukr.net

Background. The sympathetic nervous system and the kidneys exert considerable influence on the long-term control of blood pressure. The ability of the baroreflex to influence both these systems of arterial pressure regulation via the central nervous system suggests that the baroreflex may contribute to the chronic regulation of mean arterial pressure. The ability of the baroreflex to powerfully buffer acute changes in arterial pressure is well established. Baroreflex -mediated changes insympathetic nerve activity to the heart and peripheral vasculature counter short-term fluctuations in arterial pressure. While baroreflex -mediated changes in sympathetic nerve activity to the kidney may influence the renin-angiontensinaldosterone system and therefore may mediate more longterm changes in mean arterial pressure. However, it has been suggested that resetting of the baroreflex in the direction of acute and chronic pressure changes, and the observed effect of sinoaortic denervation on baroreflex indicates that the baroreflex may not be critical for setting the long-term "set point" of arterial pressure.

Blood pressure is affected by baroreflex (BR)-mediated changes in efferent autonomic nerve activity to the heart, kidneys, and other vascular beds. Mechanosensitive baroreceptor neurons constitute the afferent signal of the "BR arc" which consists primarily of arterial, cardiopulmonary, and carotid sinus baroreceptors. While BR control of the cardiovascular system is necessary to regulate blood pressure, heart rate, and sympathetic nerve activity, BR resetting may contribute to the maintenance of hypertensive states. Inappropriate regulation of blood pressure and sympathetic nerve activity is associated with structural and hormonal changes that contribute to the development and progression of cardiovascular disease and leads to further dysregulation of BP and SNA. In discussing the function and dysfunction of the BR it is useful to define its operating parameters and alterations that occur in response to BP changes.

Definitions:

• Resetting: refers to the phenomenon whereby the baroreflex operating range and pressure threshold shifts in the direction of the arterial pressure change.

• Central resetting: refers to functional and/or anatomic changes in the CNS that occur in BR resetting associated with sustained changes in BP; may be quantified using the ratio of baroreceptor input to the amount of efferent SNA.

• Efferent resetting: refers to the relative amount of change in efferent SNA as mediated by the CNS in response to reset BR signaling.

• Pressure threshold: the arterial pressure at which baroreceptors begin to fire.

• Resting point: the mean arterial pressure at which the baroreflex maintains its buffering capacity, pressures above this result in reflex inhibition of heart rate and sympathetic nerve activity, pressures below this level result in disinhibition.

• Baroreflex Gain or Sensitivity: refers to the capacity of the baroreflex to buffer changes in arterial pressure; often depicted graphically as the slope of the relationship between mean arterial pressure and heart rate, sympathetic nerve activity, R-R interval or baroreceptor firing.

• Adaptation: whereby baroreceptors activity initially increases with a sustained increase in blood pressure but declines (or adapts) over time as the elevated pressure is maintained.

• Postexcitatory depression: the suppression, or refractory period, of baroreceptor activity following a period of acute hypertension.

Conclusions. The potential for normalizing BR sensitivity and restoring the BR pressure threshold is an exciting prospect for individuals with compromised BR function (e.g., hypertension, aging, obstructive sleep apnea, and atherosclerosis). These individuals could potentially improve BP control using novel therapeutics that improves BR function through the alteration of humoral factors and molecular mechanisms responsible for baroreceptor signaling and CNS regulation of efferent SNA.

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Bibhu Charan Nayak, Hloba N.S., Isaeva I.N.

APPLICATION OF CARDIOPLEGIC SOLUTION IN CLINICAL PRACTICE

Kharkiv National Medical University, Kharkiv, Ukraine
bibhucha.nayak@gmail.com

Background. Cardioplegic solutions (CPS) are chemical solutions designed to stop the heart and reduce its energy demands during cardiac surgery. They are used by most surgeons worldwide to protect the heart from damage when its blood supply must be interrupted while the cardiac condition is corrected surgically. Most common types of heart surgeries that require cardiac arrest are coronary artery bypass graft (CABG), heart transplantation, heart valve replacement, heart congenital effects etc. The number of those surgeries carried out in the world annually increases the interest to CPS and theirs effects.

When the patient is placed on cardiopulmonary bypass (heart-lung machine), the heart is isolated from the rest of the blood circulation by means of an occlusive cross-clamp placed on the ascending aorta proximal to the innominate artery. During this period of heart isolation, the heart is not receiving any blood flow, thus no oxygen for metabolism, therefore, it needs to be protected from ischemia and necrosis, that is achieved by administration of CPS. As CPS is distributed to the entire myocardium, the ECG will change and eventually asystole will ensue. CPS lowers the metabolic rate of the heart muscle, thereby preventing cell death during the ischemic period of time.

There are 2 main types of CPS – intracellular type (Bretschneider solution) and extracellular type (St. Thomas, Buckberg solution). Intracellular are used predominantly for preservation of the heart and abdominal organs. Extracellular type is used for cardiac surgeries. According to chemical composition, CPS are divided into pure crystalloid and blood-based solutions.