Meeting Report

DISORDERS OF POSTURE AND GAIT

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The Xth International Symposium of the Society for Postural and Gait Research took place in Munich, September 2 through 6, 1990.

The International Society for Posturography was founded in 1969 by basic scientists and clinicians who had a mutual interest in the recording and analysis of body sway in normal subjects, exceptional populations, and patients. It was at the meeting in Houston in 1983 that it was realized that the interest in posturography had broadened to cover the complex question of “postural control.” In Amsterdam in 1986, it was decided that the Society should be rechristened “The International Society for Postural and Gait Research” to provide a challenging and stimulating program for the next decades rather than to confine the interest to a particular method.

Posturography is still used, and many methods of analyzing sway have been developed, including displacement of the center of foot pressure, sway path, root mean square values, sway area, sway histograms, and power spectral analysis. New techniques are, however, now in common use, the most important being EMG and reflex studies in dynamic posturography. Study of both head and trunk movements is performed, because postural balance can be simply described as the stability of an inverted multilinked pendulum. The use of electronic camera systems to measure complex body movements in three dimensions in freely moving subjects became popular. Thus, the interests of the Society which were presented by people from disciplines such as neurophysiology, engineering, neurology, otolaryngology, and physical therapy, include not only posturography but also motor physiology, sensorimotor control, and movement disorders.

Topics of the Munich meeting (Disorders of Posture and Gait, (1)) were: Control of balance in man and machine (neuroprosthesis); How to analyze posture and gait; Reflexes, synergies, and strategies; Vestibular and multisensory function; Development, adaptation, training, sport; Pharmacological effects on posture-and gait; Pathological patterns and gait disorders. In the following, aspects of the symposium and the discussions will be restricted to those presentations of particular interest in the vestibular field.

Can Posturography Measure Peripheral Vestibular Deficits?

Simple Romberg testing, that is, the ratio of body sway with the eyes closed to that with the eyes open (static posturography) is not specific enough to differentiate vestibular deficit patients from normals. New approaches to equilibrium testing and dynamic posturography will hopefully provide more sensitive identification criteria for pathological postural control than has been hitherto available (Allum, Basel). Multisensory inputs converge and provide redundant information, so that it is not critical if information from one sensory input is lost. Creating sudden perturbations by destabilizing the support surface, however, allows the differentiation between cerebellar and basal ganglia diseases or spinal cord le-
sions or bilateral vestibular deficits if this “dy-
namic posturography” is combined with lower
leg EMG-reflex studies. There is still a contro-
versy about the origin of the typical three
EMG-responses following a sudden platform
tilt about the ankle joints (toe up). The short
latency responses (M I) clearly represent the
segmental stretch reflex, whereas the origin of
the medium latency response in gastrocne-
mius muscle (M II) is unclear, and the long
latency response (M III) is probably not a
(cortical) long loop reflex or either a vestib-
ular response (Allum, Basel) or a bilateral
suprasegmental response pattern (Scholz,
Tübingen). The effects have to be analyzed
on passive biomedical trajectories of body
segments as caused by perturbations and in-
verse dynamic problems such as the torques
at all particular joints. Further development
of measurement techniques for body motion
involves either electronic camera systems or
light-weight sensors to measure angular accel-
eration and velocity which are not yet available.

The Vestibular System Stabilizes the
Head in Space during Locomotion

The common view that strategies for pos-
tural stabilization are organized from ankle
up is somewhat contradicted by the finding of
a surprising stabilization of head in space
during locomotion. Kinematic studies re-
vealed that head rotation angles (pitch) are
extremely small during locomotion which al-

dows the head to serve as a gaze anchored ref-

erence system with postural control in a “top
down” manner (Berthoz, Paris). The vestibular
system is essential for this rotational stabiliza-
tion of head in space. Labyrinthine defective
subjects have considerably larger head move-
ments during locomotion. They change strat-

ey and seem to lock the head more rigidly to
the trunk. Children below the age of 6 also
tend to anchor head to trunk during locomo-
tion. With increasing age, the strategy of
anchoring the head in space dominates (As-
saiante and Amblard, Marseille). Visual de-
privation (by darkness, or restriction of the
peripheral visual field, or stroboscopic sur-
round illumination) does not significantly af-
fect head stabilization, which supports the
view of the vestibular organ being the major
control system for head stabilization in space.

Otolithic Control of Posture

It is necessary to differentiate the roles of
utricular and saccular afferents in the vestibulo-
spinal system and the vestibulo-oculomotor
system; in particular, saccular contribution is
important in the vertical oculomotor function
and the eyeball stabilization under normal
gravity. Also, the role of the spinal ascending
system is important in the neuro-chemical bal-
cance maintenance at the level of vestibular nu-
clei, as was indicated by the study on glutamate
dynamics after unilateral utricular deafferenta-
tion (Igarashi, Tokyo).

There are data that support the view that the
otoliths do not only work in the low (<1 Hz)
frequency range but also have rapid (high fre-
quency) access to the antigravity muscles within
some 60 ms of the registration of a perturba-
tion. Early EMG-responses with a latency of
60 to 80 ms are evoked in the lower limb mus-
cles by sudden unexpected falls in man or
by toe-up support surface rotations if the
time course of head acceleration is taken into
account. In a patient with an otolith Tullio
phenomenon (due to luxation of the stapes
footplate), sound induced (otolithic) vestib-
ulo-spinal responses (EMG) occurred with a
latency as short as 47 ms (Brandt, Dieterich,
and Fries, Munich).

Immediately following space flight, astro-
nauts showed significant difficulties in postural
control under the condition of sway-referenced
support with sway-referenced vision. This could
be due to the inflight adaptive changes in cen-
tral nervous system and increased visual de-
pendency. When a Tilt-Translation Device
that partially simulates the sensory stimulus
rearrangement (between otolith-tilt and visual
field movement) was used for normal sub-
jects, the postural stability decreased and the
control strategy shifted in a manner somewhat
similar to the postflight condition (Harm et
al., Houston).
Neuroprosthesis in prolonged infancy?

It is surprising that neuroprosthesis—the most fascinating application of posture and locomotion studies—still remains in a prolonged infancy, with cloudy prognosis for convincing “adults systems” to be used outside the laboratory. Discussions on this topic sometimes sound like broken records (Jaeger, Chicago). Neuroprosthesis to assist gait and control problems, such as functional neural stimulation in paraplegics requires a knowledge of the anatomy, biomechanics, and physiology of muscles, the nervous system, and the skeleton. Current stimulation systems suffer from the well-known limitations of muscle fatigue and lateral postural imbalance (Vossius, Karlsruhe). An approach more strongly guided by physiology is required to eliminate the jerky and rather robotic movements currently produced. Future systems must make use of physiological or prosthetic sensory information to control stimulation (Quintern, Munich).

The major aim of the meeting was successfully achieved: to link basic research, new technologies, and clinical experience to develop clinical applications that can aid patients suffering from disturbances of posture and gait. The next meeting of the Society will take place in Portland, Oregon, in May 1992.

REFERENCE