A CASE STUDY

NeuroCom® International, Inc.

Simplifying Treatment Dilemmas: Comparing Two Patients

Impairments Drive Specialized Treatment Plan

Patients A and B are elderly individuals referred from family practice presenting with mild dizziness, increasing imbalance and decreased activity levels over the last several months. Patient A reports multiple 'near fall' events, whereas Patient B reports a single fall without injury. Both have known diabetic neuropathy that has been evaluated and confirmed by their neurologists. The office examination findings were similar for both patients, including:

- **Past medical history:** Non-contributory
- **Previous work-up:** Diabetic neuropathy
- **Clinical examination:** Romberg – impaired
- **Test results:** Nerve Conduction Velocities (NCV) document a mild conduction velocity slowing consistent with peripheral neuropathy affecting lower extremities

Impression: Symptoms of diabetic neuropathy are clinically significant, but do not by themselves explain the increasing imbalance and fall/near fall episodes. The current findings also do not identify a treatment plan appropriate for either patient to reach a functional outcome. Additional information is needed before treatment can be planned effectively:

1. To what extent are reported imbalance symptoms connected with the peripheral neuropathies?
2. Are there other contributing balance system factors?
   a. Poorer motor control due to the progressive neuropathy?
   b. Emerging vestibular system problem?
   c. Emerging visual system problem?
3. What can be done to minimize fall risk?

Since the peripheral neuropathy is reported to be stable, impairment measures will be used to assess balance performance and select appropriate treatment.

OUTCOMES

Evidence-based CDP testing results in objective information for individualized treatment planning. Each patient, although similar in medical evaluation results, had distinctly different impairments leading to different treatment plans.

Inside You'll Find ...

- Objective evidence differentiating the clinical picture of two patients with similar symptoms and medical histories.
- Focused management and an individualized approach to successful outcomes.

Measuring Impairments

A focused review of the balance system was carried out to determine the possible reasons for the falls and solve the clinical dilemmas presented by the patients. The following tests were conducted to isolate and quantify impairments and to determine their relationship to the patients' symptoms of imbalance.

Balance Control: Computerized Dynamic Posturography (CDP) was the protocol used for differential impairment diagnosis of the two patients. CDP is comprised of the Sensory Organization Test (SOT), the Adaptation Test (ADT), and the Motor Control Test (MCT). The Sensory Organization (SOT) (Figure 1A-B) subtest evaluates the effective use of the sensory systems required for postural control. The Motor Control subtest (MCT) (Figure 2A-B) measures the effectiveness of automatic motor responses needed to recover from unexpected perturbations. The Adaptation (ADT) (Figure 3A-B) and Limits of Stability (LOS) tests examine the control of adaptive movement strategies and voluntary movement control.

Although the medical histories for both patients are similar, the impairment assessment illustrates important differences that will necessitate different treatment plans.

Sensory Organization Test

Patient A

Poor performance on SOT 4,5,6.

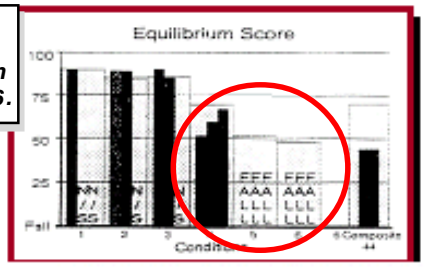
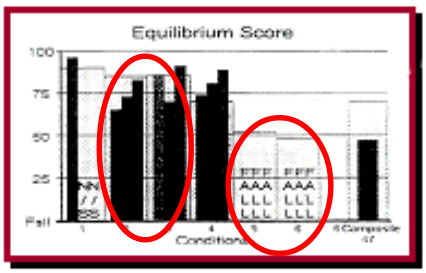


Figure 1A (pre-treatment): Patient A is over-reliant upon somatosensory cues for balance (ineffective use of visual and vestibular cues).

Patient B



Poor performance on SOT 2,3,5,6.

Figure 1B (pre-treatment): Patient B is over-reliant upon use of visual cues for balance (ineffective use of somatosensory and vestibular cues).

SOT conditions 4, 5, and 6 all provide distorted proprioceptive information by forcing the support surface to sway in response to the patient's postural sway. Conditions 5 and 6 challenge, remove or distort visual information while sway referencing the support surface, thereby placing a high demand on vestibular information.

For Patient A, attempts at balance recovery under conditions 4, 5, and 6 of the SOT suggest that the patient is receiving information from the visual and vestibular systems but is ineffective at centrally coordinating this information (Figure 1A).

Patient B demonstrates difficulty with conditions 2, 3 (missing or distorted visual information). "Dead fall" in conditions 5 and 6 (high vestibular demand), indicate that the patient is totally unresponsive to vestibular cues. This was suggestive of a profound bilateral vestibular disorder and resulted in a referral for an ENG..

Motor Control Test

Patient A

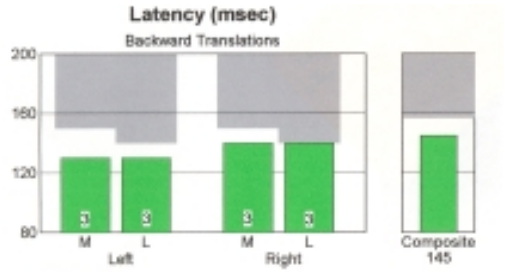


Figure 2A (pre-treatment): Borderline normal automatic motor response latencies.

In terms of automatic movement control, Patient A was within normal limits for latency and symmetry.

GREEN = normal age-matched performance. RED = outside normal range.

Patient B

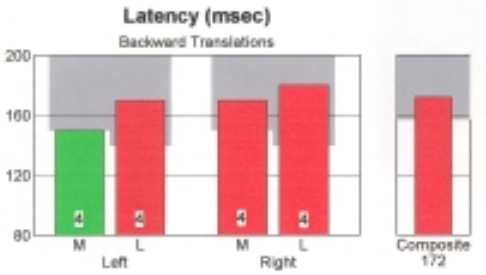


Figure 2B (pre-treatment): Delayed automatic motor response latencies.

Results for Patient B show both asymmetrical results and abnormally prolonged latencies, indicating severe motor impairment suggestive of worsening of his neuropathy.

Adaptation Test (ADT)

Patient A

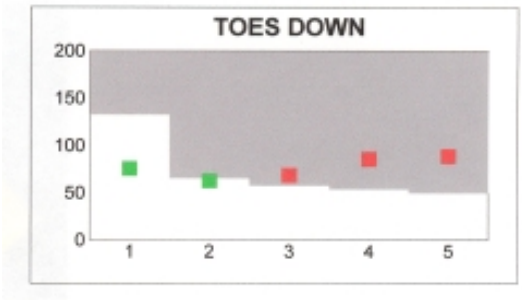


Figure 3A (pre-treatment): A mild impairment in the ability to adapt to a series of five similar toes-down perturbations.

ADT results for Patient A indicate poor adaptation to a toes-down perturbation, with repeated exposures. (A normal response is improved stability over time.) This suggests that Patient A may have more difficulty with unpredictable surfaces, contributing to a higher risk of falls.

Outside age-matched normative performance range.

Patient B

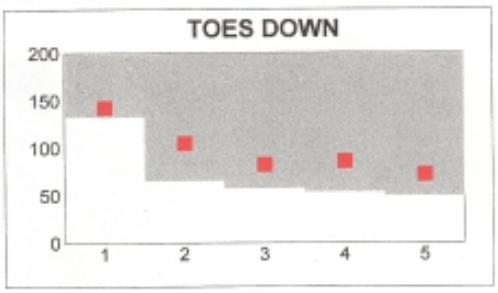


Figure 3B (pre-treatment): Inability to adapt (generate adequate force response) to the toes-down perturbation series.

Patient B shows abnormal postural responses to all toes-down perturbations, but with less sway for subsequent trials. This suggests that central adaptive mechanisms were still intact, although functionally the patient is currently at a higher risk for falls.

These tests provide unique information regarding the distinct clinical differences between the two patients, as well as to their individualized management strategy and prognosis.

Impression & Recommendation

Clinical Findings — Patient A

Results confirm a sensory balance impairment, characterized by significant difficulty in integrating vestibular information and, to a lesser extent, visual information, rendering the patient over-reliant on somatosensory information for balance control. MCT results show that motor response latencies are within normal limits, suggesting that the diabetic neuropathy is not contributing to the balance problem. Based on the SOT results, central integration of vestibular information is impaired, and the prognosis for improving balance function with exercise therapy is excellent.

Clinical Findings— Patient B

ENG results indicate bilaterally very weak/absent vestibular responses. CDP results identify impairment, with both sensory and motor components. Given the patient's inability to access vestibular cues (SOT) and the impaired proprioceptive motor responses (MCT), indicative of a significant contribution of the neuropathy, the prognosis for improving balance function with exercise therapy is poor. With two of the sensory systems impaired, the substitution strategies typically used to improve balance in patients with losses limited to a simple sense are unlikely to be successful.

How did the examination help to determine if the vestibular function was adequate for return to basic function?

- **Past medical history:** Non-contributory
- **Previous work-up:** Diabetic neuropathy
- **Clinical examination:** Romberg – impaired
- **Test results:** Nerve Conduction Velocities (NCV) document a mild conduction velocity slowing consistent with peripheral neuropathy

Patient A

The impairment data indicate that there may be vestibular sensory information available to the patient, and he can be trained to use it more effectively. In addition, the patient can learn to be less dependent on proprioceptive information and acquire improved postural control strategies for unpredictable surfaces. The prognosis for improved balance function and reduced fall risk is good.

- Based upon the SOT findings, the patient was referred to ENT for electronystagmography (ENG) to determine whether vestibular impairment was due to peripheral or central loss. Results of ENG testing were consistent with a partial bilateral peripheral loss of vestibular function.
- Based on the potential for recovery of vestibular and visual control, the patient was referred for vestibular and balance retraining therapy.

Patient B

The combination of medical findings (peripheral neuropathy, reduced NCV), poor motor performance (MCT), and over-reliance on visual information combine to suggest that the potential to improve use of available proprioception may be limited, as is the potential to improve automatic motor control for balance.

- Based upon SOT results, the patient was referred for ENG testing. Results show no measurable response to ice water calorics bilaterally, confirming bilateral vestibular disorder.
- Based on MCT results, repeat EMG/NCV were requested. Results indicated deterioration of the peripheral neuropathy, suggesting limited rehabilitation potential as related to proprioceptive function.

The patient is referred to rehabilitation primarily for patient education, lifestyle modification, with individualized and limited balance retraining therapy.

Overview

Physical Exam/History

Patient A: Imbalance
- Diabetic Neuropathy

Patient B: Imbalance
- Diabetic Neuropathy

Diagnostic Hypotheses

1. Deterioration of peripheral neuropathy?
2. Vestibular system problems?
3. Visual system problems?

Medical Work-Up

Diagnostic Testing
None; NCV six-months prior

Medical Work-Up
Negative

Blood Pressure
OK

Observational Tests
- Romberg
- Gait

Impaired

Diagnosis

1. Rehabilitation?
2. Additional diagnostic tests?
3. Repeat NCV?

Impairment Work-Up

Tests of Postural Control

Computerized Dynamic Posturography
Sensory Organization Test (SOT)
Motor Control Test (MCT)
Adaptation Test (ADT)
Limits of Stability (LOS)

Impairment Diagnosis

Patient A: Sensory balance problem?

Patient B: Bilateral vestibular loss?

Additional Testing

Patient A:
Additional tests:
ENG - partial bilateral vestibular loss

Patient B:
Additional tests: ENG - profound bilateral vestibular loss; NCV -worsening proprioceptive function

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Functional Outcome

Patient A:
Somatosensory dependence with good prognosis.

Patient B: Lifestyle modifications (use of cane) and supervision in low lighting situations.

Summary: How did CDP augment the medical decision-making?

1. *CDP showed that the patients similarly lacked adequate vestibular compensation and were successfully treated with individualized treatment plans.*
2. *CDP directed the management approach in general and the vestibular rehabilitation approach specifically.*
3. *CDP provided an objective benchmark for safe and independent function.*

Treatment Plan

For Patient A, balance retraining therapy was focused on training activities on unstable surfaces to facilitate the use of visual/vestibular cues for balance control (sensory re-weighting). In Patient B, therapy was focused on training activities with altered visual inputs to facilitate the use of somatosensory inputs for balance control to the extent possible (sensory re-weighting). In Patient A, the primary focus was to force the use of visual and vestibular cues within movement tasks. In patient B, the treatment focus was limited to a goal of maximizing the use of sensory information from his available systems (somatosensory and visual cues) and on necessary lifestyle changes to avoid situations that place the patient at risk (when under vestibular-type demand).

Patient A
Impairment: Balance Stability

Findings: Sensory balance problem characterized by somatosensory dependence. Good prognosis.

Force use of visual and vestibular cues with visual biofeedback

- **Progressive altered surfaces with eyes open, closed, head turning**

Duration: three times per week for 60 days

Patient B
Impairment: Balance Stability

Findings: Severe sensory and motor balance problem characterized by visual dependence, poor voluntary, adaptive, and automatic motor control. Prognosis limited.

Maximum use of somatosensory system cues with visual biofeedback

- **Firm surfaces with altered visual cues (eyes open, eyes closed, head turns)**
- **Performed voluntary weight shifting activities in anterior and posterior directions designed at tasks**
- **In preparation for mobility training including gait**

Duration: three times per week for 30 days

Functional Outcome

Both individuals achieved safe and independent function within 60 days. Patient B required modifications including use of a cane to maximize somatosensory input and supervision in conditions of low lighting. Both individuals will be monitored throughout the course of their disease progression on an as-needed or yearly basis.

Primarily, the ability to discriminate between and narrow the focus for treatment was essential information for appropriate and complete resolution.

Influence from CDP/computerized tests on patient management:

The addition of CDP and additional computerized testing of the status of balance functions provided:

- Objective evidence supporting each patient's complaints and symptoms
- Objective evidence differentiating each patient's problem (impairments)
- Appropriate individualized pathway for treatment
- Realistic treatment prognosis based on impairment differentiation
- Post-treatment objective evidence that the management strategy was effective

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