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Abstract: Stroke is the leading cause of disability in the United States. Each year about 795,000 suffer a stroke. Over 650,000 survive and need varying levels of rehabilitation. Unilateral Spatial Attention (USI), also known as left hemi-neglect, is a potential sequela of stroke, especially with involvement of the middle cerebral artery, the vessel most commonly affected by stroke. Two recent studies have reported the rate of USI to be 50% in those who have had a right hemispheric stroke. Patients with USI are unable to perceive objects in their contralesional visual field, even though their visual pathway is intact. USI may also manifest in patients’ visual memory, their perception of their body, and their ability to move to the contralesional space. The prognosis for recovering independent function in patients with USI is worse than those with other deficits, and thus should be recognized and treated. Patient T.P. exhibits many of the classical behaviors and test results of patients with USI, and also demonstrates some of the unique features of the condition. This case report will demonstrate the screening tests for USI, as well as familiarize the clinician with Visual Midline Shift Syndrome, Pusher Syndrome, Extinction Phenomenon, and Cross-Over Phenomenon. Neurophysiology of the condition as well as the compounding effect of damage to the Frontal Eye Fields will be reviewed. Multiple passive and active treatments in the literature will be discussed, including T.P.’s very positive initial experience with monocular sector prism, which increased his visual field 10-15 degrees. Initial training to help T.P.’s brain readjust to the spatial orientation of objects seen through the prism has been very promising.

I. Case History
   a. 58-year-old Caucasian male
   b. CC: Unable to see to do things used to do: fishing, carving, making wind chimes, fix-it projects. Also, decreased confidence walking and feels like he will “fall into a void on his left.” Walks to the right, even if it’s towards traffic.
   c. Ocular, Medical History
      i. Right middle cerebral artery ischemic stroke in right parietal lobe 6 years ago
         I. Hospitalized for seven weeks with intensive OT, PT and speech rehabilitation
         II. Diagnosed with left hemianopsia at rehab admission screening Jan 20, 2005
         III. Inferior quadranopsia on FDT screener Feb 22, 2005
      ii. HTN, high cholesterol, history of seizure several months post-stroke, depression, colonic polyps
      iii. Uses separate pairs of reading and distance glasses, but mostly reads without glasses
d. Medications
   i. Lisinopril, Omeprazole, Lovastatin, ASA, Baclofen, Citalopram

e. Other Pertinent
   i. Frequently bumps into things on the left
   ii. Feels more confident walking with buildings on his right side.
   iii. Fell and broke ribs last year
   iv. Left hemi-paresis
      I. Uses wheelchair but can stand and walk
      II. No feeling to left arm – burned on BBQ
   v. Often does not eat food on left side of plate
   vi. Often does not comb hair on left side
   vii. Now leans and turns head to the left. Shortly after stroke, leaned to the right
   viii. Difficulty reading
   ix. Difficulty with math post-stroke
   x. Sensitive to noise, but not photophobic
   xi. Walls or floors do not appear tilted as may occur with Visual Midline Shift Syndrome

II. Pertinent Findings
   a. Clinical
      i. OD: -1.50 20/20 +2.50 (Separate distance and near glasses)
         OS: -1.25 20/20 +2.50
      ii. Pupils: PERRL – APD, EOMs: Full, unrestricted
      iii. CFVF: Homonymous Left Inferior Quadrantanopsia
           (-) Dual Extinction
      iv. Near CT: 10XP with slow response OD on alternate CT
      v. NPC: 10 cm
      vi. Red lens test: Fusion, but weak response OD
      vii. Visual Midline Shift Syndrome testing: (+) for VMSS with increased attention demand of standing
           I. Sitting: aligned
           II. Standing: Possible VMSS. When tracked from the left, aligned. When tracked from right, midline consistently shifted to the right. Aligned with 8 pd
      viii. Humphrey VF 30:2 Sita Fast: Homonymous left inferior quadrantopsia. Peripheral defect in left superior quadrant
   b. Physical
      i. Leans and turns head to the left
      ii. Cannot lift left arm or hold anything in the left hand
      iii. Weak left leg
   c. Laboratory Studies - none
   d. Radiology – none (may be able to obtain a copy of MRI)
   e. Other
i. Flower Copy Test: Crowding towards right side. Petals drawn almost entirely on the right side (see attached document)

ii. Clock drawing: Crowding to the right. Left out numbers 10 and 11 (see attached document)

iii. Line Bisection: Slightly to the right

iv. Star Cancellation: Missed few in upper left quadrant and all in inferior left quadrant

v. BiVABA (Brain Injury Visual Assessment Battery for Adults): failed word search and complex circles search

vi. MVPT: <1%-ile

vii. Beery VMI: 2%-ile

viii. Subjective: Attention difficulties, became worse at perceptual testing with time

III. Differential Diagnosis

a. Unilateral Spatial Inattention, left hemianopia, Pusher Syndrome, Visual Midline Shift Syndrome, motor weakness secondary to stroke, visual perceptual deficit

   i. Left hemianopia vs. USI (May be present together)

      1. Line bisection task: USI - patient will bisect towards field ipsilateral to lesion. Hemianopia - patient will bisect toward contralateral field.

      2. Scan paths – patient with USI will have more abnormal and fewer scans to abnormal field

      3. Visual acuity testing - both will miss letters on left of chart, but when pointed out, patient with hemianopia will scan and correct

IV. Diagnosis and Discussion

a. Elaborate on the diagnosis

   ii. USI will look like VF defect

   iii. May be concurrent with VF defect

   iv. May vary in density

   v. May change with attention demands, posture

   vi. May be personal space, extra-personal space or peri-personal space

   vii. Three categories of USI:

      1. Memory and representational deficits (Visual Memory and imagery of that space in the patient's mind)

      2. Action-intentional disorders (motor neglect): Inability to move in field contralateral field despite limb strength

      3. Inattention to contralesional field

   viii. Spectrum of severity

   ix. Most spontaneous improvement occurs in the first year

   x. Patient aware of left inferior quadranopsia, but not aware of USI
b. Expound on unique features
   i. Unilateral Spatial Inattention almost always on left side
      1. Right parietal lobe has "Big Map" of personal spaces and external spaces which allocates attention to both sides of the body
      2. Left parietal lobe allocates attention to the right side of the body (serves as back up for right side)
   ii. Extinction Phenomenon: Patient may recognize contralesional stimuli presented alone, but are unable to detect the stimuli when competing stimuli are also present in the patient’s ipsilesional, intact field (Dual presentation in confrontation visual fields important)
   iii. Pusher Syndrome: Patients push their weight away from their non-hemiparetic side too their hemiparetic side
      1. Areas of lesion that cause this syndrome: Multiple areas of right cerebral cortex or posterior thalamus on either side
      2. Disorder found in 10.4% of patients with acute stroke and hemiparesis.  
      3. Copenhagen Stroke Study found that patients with Pusher Syndrome used 3.6 more weeks to reach the same functional outcome on the Barthel Index. 
   iv. Damage to frontal lobe and Frontal Eye Fields (FEFs) contributes to Unilateral Spatial Inattention because of the FEF’s role in exploring eye movements (scanning)
   v. USI can be present after traumatic brain injury, but is most commonly present after stroke, especially when the middle cerebral artery is involved (as with out patient)
   vi. Cross-Over Phenomenon - patients will bisect long horizontal lines to the right of center and short horizontal lines to the left of center. Patients with quadranopsia show this phenomenon with lines that passed into their blind quadrant
   vii. Visual perceptual testing: be aware of neglect, test in visible field

V. Treatment, Management
   a. Treatment and response to treatment
   1. August 24, 2011
      1. After testing, discussed things to do at home:
         a. Wife and others sit to patient’s neglected side
         b. Do word searches or Sudoku to left of midline
            1. Doesn’t have as much interest in these anymore
         c. Compensating strategy - tilt book to read uphill, red strip of paper on the left side of page in book,
or highlight left of page to draw attention

I. Helped patient read a little more fluently

2. August 31, 2011
   1. Different prism configurations trialed:
      - Fresnel base left yoked prism over entire lens OD, OS
      - EP Fresnel sector strip base left in lower portion of left lens
      - Fresnel base left sector covering left portion of lens
      - Fresnel base left button in lower left portion of lens
      - Fresnel base left sector covering entire lower portion of lens
        below line of sight in primary gaze
   2. Demonstrations of different powered yoked prisms
      a. Patient noticed shift in field with yoked 5pd and 10pd, but felt that 15pd was “too strong.”
   3. Trained with prism: For button and left sector, need to move eye to look through prism.
   4. Prisms demonstrated increased patients left peripheral field by 10-15 degrees.
   5. Patient liked Fresnel sector prism covering entire lower portion of the lens the best. Next, the binocular full field.
   6. Subjective: “I can see that left wall now.” “I can see all of it now. It brings it right up.”
   7. Began training to readjust brain to spatial orientation of objects with prism by reaching and touching objects.
   8. Questionnaire about daily activities sent home with patient to return next week. Will answer questions again in one month.

3. Future Treatment Options
   1. OKN and VOR stimulation of leftward eye movements
      a. Reflex overrides inattention
   2. Move around the room to the left with eye movement to the left every time pick up left foot, drop things into bucket on left
   3. Margolis Eye Throwing Technique
   4. Teaching eye scanning - large objects, flashing lights or sound, move to smaller targets
   5. Tanagrams, Parquetry, Geoboards
   6. Flashing lights, Dynavision
   7. Fresnel Prism during training sessions (observe effect of head turn, reaching, walking, posture)
a. Often immediate improvement but initially decreases with removal of prism; however, with time, improvement becomes more permanent
b. One hour session 2-3x/day interspaced with 1-2 hours of non-wear

4. Right Biocular Patches
5. Computer Programs (would also be good for visual perceptual deficits)
   1. Vision Builder (Peripheral, saccades, tennis, track letters)
   2. PTS2 (Visual Sequential Processing)
   3. HTS (Pursuits, Saccades)
6. Wristband on left arm to increase awareness (since cannot squeeze ball or hold object in left hand due to paresis)
7. Vestibular stimulation (Vestibular canals are in line with EOMs)
   1. Rotate chair to left with visual motor task such as finger point or catching ball
8. Galvanic stimulation of vestibular nerve
   a. Short-lived results: reducing USI for one day
9. Caloric Irrigation (temporary remission)
10. Vibrating posterior neck muscles, or lengthening muscles by rotating the trunk 15 degrees to the right

b. Refer to research where appropriate
   1. Ross et. al. showed that after four weeks of wearing prism, patient showed significant improvement on visual perceptual tests
   2. Eli Peli on function of monocular prism segments
      a. Pre-adaptation period - patient sees extra visual information but two objects appear to be in the same location.
      b. Post-adaptation period – prism views are perceived in their correct spatial location
3. Suchoff (continuum)

Bibliography
4. Rummel, E. Vision therapy can correct deficiencies from hemianopsia. *ADVANCE for Directors in Rehabilitation* 14:49.

VI. Conclusion

   a. Clinical pearls, take away points if indicated
      i. Many USI patients undiagnosed
         1. For practitioners not specializing in USI, the Star Cancellation Test, is a sensitive, simple tool to detect the condition and make the appropriate referral
      ii. It is important not to teach scanning with head movement, which embeds USI
         1. Wearing headlamp can give patient feedback on whether they are moving their head rather than eyes
      iii. When administering visual perceptual tests to a stroke patient, keep in mind they may neglect part of their visual field. Do they always choose incorrectly when the answer is A? May need to shift test booklet.

(Please see additional attachments for flower and house copy test, clock drawing, and visual field)

I will be continuing to work with this patient and will have additional information about his progress at Academy.