15) PENCIL PUSH-UP “THE ECONOMICAL AND EASY ANSWER TO SYMPTOMATIC CONVERGENCE INSUFFICIENCY”

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ABSTRACT

Aim: To determine the effect of home based pencil push-up exercise for patients having symptomatic convergence insufficiency.

Methodology: In this prospective interventional study 62 patients between the ages of 6 to 23 yrs diagnosed of having convergence-insufficiency were enrolled. Patients’ pre exercise duration of symptoms, refractive errors, distant & near deviation angles & near point of convergence noted at baseline & at each subsequent visit. Follow up of 16 weeks was done (0, 4, 8, 12, and 16). Patients were given a strict exercise protocol (10 mins 3 times a day) under the observation.

Results: Mean age of patients ranged from 16± 7.7 yrs with a male: female ratio 1.3:1. At baseline Mean deviation of angle at distance was 3.1±1.6PD & at near 10.5±2.4PD. The near point of accommodation was within normal limit for the age. After 16 weeks of exercise mean angle of deviation became orthophoric at distant and reduced to 3.8±1.4 PD at near. At study endpoint (16 wks) Near point of convergence became 13.8±5.1cm from 26.1±7.2cm at baseline. This improvement was statistically significant (p=0.0001).

Conclusion: Home based pencil push-up exercise proved to be a cost free & easy therapy for patients with symptomatic convergence insufficiency during the study period.

Introduction:

Convergence insufficiency is one of the most common causes of ocular discomfort and the most common cause of muscular asthenopia. Symptoms of convergence insufficiency include eyestrain, headaches, blurred vision, diplopia, difficulty concentrating on performing close-up activities. In the evaluation of patients with ocular asthenopia, convergence insufficiency should be a part of the differential diagnosis. This condition is characterized by a patient’s inability to
converge the eyes smoothly and effectively as the object of visual interest moves from distance to near and/or the inability to maintain the convergent near point\textsuperscript{12}. This ineffective muscular action can cause loss of proper binocular alignment with a resultant exophoria or intermittent exotropia at near\textsuperscript{8}. Associated with convergence insufficiency is a wide range of symptoms that can vary from mild to severe. Patients can be particularly distressed when they experience binocular diplopia at near.

The current reports sight a frequency of convergence insufficiency between 2.25 and 8.3\% but these numbers originate from clinical studies on school age children \textsuperscript{2,3}

**Clinical findings:**

The diagnosis of convergence insufficiency is based on the symptomatology\textsuperscript{7,8} as well as the physical findings.

- **Remote near point of convergence:**
  A remote near point of convergence is the most consistent finding in convergence insufficiency. Normal young children have an excellent ability to converge and can maintain convergence easily 1–2 cm from their nasal bridge. Adults have slightly more difficulty but normally can maintain convergence in the 3–4 cm range.

  Many authors use a remote near point of 10 cm to define patients with convergence insufficiency

  However, according to The Convergence Insufficiency Treatment Trial\textsuperscript{4} (CITT) at least 6 cm is considered as the remote NPC.

- **Decreased fusional convergence:**
  The stimulus for fusional convergence at near is disparate retinal imagery. Fusional convergence amplitudes or positive fusional vergence is the amount of convergence available to overcome temporal disparity in order to maintain binocular fusion at near.

  Base-out prisms are used to measure fusional convergence\textsuperscript{11,13}. In convergence insufficiency it is common to see low fusional convergence amplitudes and thus an inability to maintain near fixation.
Phoria or tropia
Most patients with convergence insufficiency will demonstrate varying degrees of exophoria or even an intermittent exotropia at near. The presence of orthophoria at near does not rule out convergence insufficiency.

Multiple treatments options are available for convergence insufficiency. Which include Passive treatment like base-in prism reading glasses that helps in relieving the symptoms and Active treatments like Pencil push-ups/accommodative target. Home-based pencil push-ups (HBPP) therapy in many studies have shown to improve the symptoms as well as the clinical signs. Recent studies have suggested that HBPP therapy is the most commonly prescribed treatment by both ophthalmologists and optometrists for symptomatic convergence insufficiency.

Aim and objective:
This study was done to determine the effect of home based pencil push-up exercise for patients having symptomatic convergence insufficiency in patients attending our strabismus clinic.

Materials and Methods:
In this prospective interventional study conducted at strabismus clinic of C.H. Nagri Eye Hospital during the time period of November 2010 to April 2011. We enrolled 62 patients between the ages of 6 to 23 years having symptomatic convergence insufficiency.

Inclusion and exclusion criteria are listed below.

Inclusion criteria:
- exodeviatio at near at least 4Δ greater than at far,
- a receded near point of convergence (>10cm)
- Insufficient positive fusional vergence at near (PFV) (i.e. convergence amplitudes failing Sheard’s criterion PFV less than twice the near phoria or minimum PFV of ≤15Δ base-out blur or break)

Exclusion criteria:
- Patients with abnormal NPA,
- Amblyopia
- Anisometropia
- Previously treatment with prism glasses,
- History of strabismus surgery,
- Presence of any other ocular abnormalities,
- Systemic diseases

All the patients attending the strabismus clinic of C.H Nagri Eye Hospital were examined by a strabismologist and patients considering the mentioned inclusion and exclusion criteria were included in our study. Comprehensive ophthalmic examination which included Best-corrected visual acuity (BCVA) and refraction, Patients’ pre exercise duration of symptoms, refractive errors, best corrected visual acuity, distant & near deviation angles & near point of convergence noted at baseline & at each subsequent visit.

Patients were followed up for a period of 16 weeks (0, 4, 8, 12, and 16). The patients were instructed on the use of HBPP therapy prior to starting treatment. Patients and their parents were demonstrated how to correctly perform HBPP therapy before leaving the clinic.

**HBPP exercise method:**

Patient was taught to hold a pencil at arm’s length positioned approximately midway between the eyes. Patient was then instructed to look at and attempt to maintain a single image of the pencil while it is being moved toward the nose. The patient is told to continue moving the pencil toward the nose until it is no longer possible to view the pencil as a single image. At this point, the pencil should be positioned at the most closest point at which a single image is achieved. If the patient is not able to regain a single image, the entire procedure must be repeated. Patient was instructed to perform the pencil push-ups procedure 10 mins 3 times a day with their refractive correction in place under the observation of their parents or guardian.

**RESULTS**

Table shows Baseline variables for the 62 patients in the study. The mean age of the patients was 16 years (range, 6 to 23 years). The mean refractive error (spherical equivalent) was -2.3± 1.2 D in the right eyes and -1.9 ± 0.9 D in the left eyes. There was no difference in mean refractive error between the two eyes (p > 0.05).
• **Baseline variables:**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age</td>
<td>16 ± 7.7 yrs</td>
</tr>
<tr>
<td>Male : female ratio</td>
<td>1.3:1</td>
</tr>
<tr>
<td>Mean deviation of angle at distance</td>
<td>3.1 ± 1.6PD</td>
</tr>
<tr>
<td>Mean deviation of angle at near</td>
<td>10.5 ± 2.4PD</td>
</tr>
<tr>
<td>Near point of convergence</td>
<td>26.1 ± 7.2cm</td>
</tr>
<tr>
<td>Near point of accommodation</td>
<td>Normal for all ages</td>
</tr>
<tr>
<td>positive fusionalvergence at near</td>
<td>10.1 Delta</td>
</tr>
</tbody>
</table>

• **End of study variables:**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean deviation of angle at distance</td>
<td>orthophoria</td>
</tr>
<tr>
<td>Mean deviation of angle at near</td>
<td>3.8±1.4 PD(p=0.0001)</td>
</tr>
<tr>
<td>Near point of convergence</td>
<td>13.8±5.1cm(p=0.0001)</td>
</tr>
<tr>
<td>Near point of accommodation</td>
<td>normal</td>
</tr>
<tr>
<td>positive fusionalvergence at near</td>
<td>25.3 Delta(p=0.0001)</td>
</tr>
</tbody>
</table>

1. Successful outcome was defined as achievement of both normal near point of convergence (NPC) (<6 cm) and normal positive fusionalvergence (PFV) (>15 PD);
2. Improved outcome:
   - at least one of the followings, 1) a normal NPC, 2) an improvement of greater than 4 cm in NPC, 3) a normal PFV, 4) an increase of greater than 10 PD in PFV
3. those who did not meet the criteria were defined as Non-responders.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Successful outcome</td>
<td>32</td>
<td>51.61%</td>
</tr>
<tr>
<td>Improvement</td>
<td>12</td>
<td>19.35%</td>
</tr>
<tr>
<td>non responders</td>
<td>14</td>
<td>22.58%</td>
</tr>
</tbody>
</table>
Discussion

HBPP therapy is a simple, cost-free and easy to learn. In this study the effectiveness of 16 weeks of HBPP therapy was evaluated. The results from the present study indicated that 77.41% of the patients showed either successful or improved outcomes after 16 weeks of HBPP therapy.

In multiple studies\textsuperscript{1,5,9} office based therapy has shown to be more effective than home based therapy, but in our study even home based pencil push up showed very encouraging results.

Kyung et al\textsuperscript{1} showed similar results as our study; with mean deviation angle decreased to orthophoria at the end of study period for distance as in our study and 4 PD for near as it became 3.8±1.4 PD for near in our study.

Convergence Insufficiency Treatment Investigator Group (CITI group)\textsuperscript{4,5} in their randomized Trial suggested statistically significant improvement in NPC and PFV and improvement in mean deviation angle of at distant and at near which were similar to our results.

limitation of our study:

One of the major limitation was that we excluded patients with abnormal NPA in order to rule out convergence insufficiency associated with accommodative insufficiency. This may be a possible explanation for the relatively higher success rate observed in the present study because symptomatic convergence insufficiency with normal NPA have shown to respond very well to ophthoptic treatment but patients with abnormal NPA do not respond well to any type of orthoptic training.
Other important limitations were a small sample size and lack of symptom level measurement using the questionnaire. In addition to it, the patients were not divided into children and young adult groups as they were in other studies.

However, randomized control trial with larger sample size is needed to confirm these findings.

**Conclusion:**

Home based pencil push-up exercise proved to be a cost free & easy therapy for patients with symptomatic convergence insufficiency during the study period. Therefore in country like ours where resources are limited, home based pencil push up therapy is cheap, economical, easy and highly effective mode to tackle symptomatic convergence insufficiency.

**Foot note:**

No financial conflicts to declare.

This paper was read in 40th all Gujarat ophthalmological society annual conference 2012 held at surat, Sep 2012.

This paper is also accepted to be broadcast as E poster at the Asia pacific Academy of ophthalmology annual conference to be held in Hyderabad Jan 2013.

**Reference:**

   PMCID: PMC3102822 Effectiveness of Home-Based Pencil Push-ups (HBPP) for Patients with Symptomatic Convergence Insufficiency
2. “Convergence insufficiency and its current treatment” Volume 21, Issue 5, September 2010, 356-60.DOI: 10.1097/ICU.0b013e32833cf03a


