Determining the ideal optotype size for pitch plane interventions: an exploratory study

Regan G Harrell, Brooke N Klatt, Pedram Hovareshti, Susan L Whitney

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Regan G Harrell[1] PT, DPT; Brooke N Klatt[1] PhD, PT, DPT; Pedram Hovareshti[2] PhD; Susan L Whitney[1] PT, DPT, PhD

[1]Department of Physical Therapy School of Health and Rehabilitation Sciences The University of Pittsburgh Pittsburgh US
[2]BlueHalo Rockville US

Corresponding Author:
Regan G Harrell PT, DPT
Department of Physical Therapy
School of Health and Rehabilitation Sciences
The University of Pittsburgh
100 Technology Dr
Pittsburgh
US

Abstract

Background: Clinicians prescribe vestibulo-ocular reflex (VOR) exercises when there is a deficit in gaze stability associated with vestibular hypofunction. The exercises aim to maintain focus on an object while the head is moving in the pitch and yaw planes. Many people who complete VOR exercises use progressive or bifocal lens. For multi-focal corrective lenses, the user must look through the correct part of their lens when viewing targets in the pitch plane.

Objective: This study aimed to identify if healthy multi-focal corrective lens users had difficulty with VOR exercises in the pitch plane based on optotype size.

Methods: Participants completed VOR exercises on the VestAid tablet, which can record both eye gaze compliance and head movement compliance. Participants completed pitch plane VOR exercises at 80 bpm with optotype sizes 14-, 16-, 18-, 20-, and 22-point fonts for 30 seconds in the seated position with no visual background. All participants then rated symptom severity (dizziness, nausea, headache, fogginess) and overall level of exercise difficulty.

Results: Twelve healthy multi-focal correct lens users (seven progressive and three bifocal lens users) completed the study. All participants were 100% compliant with moving their head at the correct speed and 100% compliant with maintaining their eyes on the optotype during the exercises regardless of the optotype size. Participants rated all exercises as “extremely easy.”

Conclusions: There was no difference in optotype performance in healthy multi-focal corrective lens users when completing pitch plane VOR exercises. Additional work is needed to determine if optotype size makes a difference in gaze stability in persons with vestibular hypofunction.

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Introduction:

Vestibular rehabilitation involves several exercises that include performing head movements that require the person to move their head in the pitch and yaw planes while focusing on an object to improve the vestibulo-ocular reflex (VOR) gain [1]. The exercises include focusing on a target of interest while moving the head in the plane of motion at a set speed[2]. The VOR exercises are low-tech as the patient is often asked to view text on a tongue depressor or post-it note as they move their head while keeping the text in focus. As technology advances, there are now higher-tech applications for monitoring compliance with VOR exercises[3-5]. There is no consensus about the correct size optotype for the VOR exercises in these new application-based programs.

As part of normal aging, many adults require corrective lenses for close vision [6]. These corrective lenses can be bifocal, trifocal, or progressive in nature [6]. Using corrective lenses forces the wearer to learn how to focus on different targets at different distances in various parts of their lens[6,7]. Users of progressive lenses require a greater degree of compensatory eye rotation for a given head rotation [7]. The increased demand on ocular movement can sometimes be challenging for wearers, resulting in discomfort, headaches, and nonuse of glasses [8].

As vestibular disorders are often associated in older persons who wear corrective lenses, use bifocals, trifocals, or progressive lenses may complicate their VOR adaptation and make focusing on the target while performing their home exercise program challenging. When prescribing an exercise program, it is unknow if eyewear affects the ability of a person to maintain focus as they move their head doing VOR exercises. The study aims to determine if there is a difference in gaze stability compliance in healthy subjects who use corrective lenses based on optotype size.

Methods:

Data were collected from twelve healthy subjects who wear progressive lenses. Using their corrective lenses, all participants completed vertical VOR testing using the VestAid tablet app [9]. The VestAid tablet app can record the accuracy and compliance of both head and eye movements while performing VOR exercises [9]. Through eye and facial recognition software, the VestAid can record

the percentage of time that a patient can keep their eyes on the target (eye gaze compliance accuracy). All participants provided consent and The University of Pittsburgh Biomedical IRB approved the study (STUDY21050062).

The subjects sat one meter away from the device and completed all five rounds of vertical VOR with a white background and pink optotype at 80 bpm. The optotype size varied from round to round, including 14-, 16-, 18-, 20-, and 22-point fonts. The fonts were presented randomly from subject to subject in the order presented. Each subject, before every round of VOR exercises, was asked to rate from “extremely easy” to “extremely difficult” on a 0-10 scale for any symptoms they were experiencing (dizziness, lightheadedness, fogginess, and nausea) on a 0-10 scale. After completing the exercise, they again reported any symptoms and rated how challenging the exercise was from extremely easy to extremely difficult.

Results:

Of the twelve subjects who completed the study, nine were female, and three were male. The average age was 51 (SD =4), and all had worn progressive lens for at least a year before testing. Seven of the subjects use progressive lenses and three use bifocal lenses. Table 1 shows the results of the VestAid protocol. The average head compliance for all optotype sizes was 100%, and the average eye gaze stability for all optotype sizes was 100%. Across all optotype sizes, all participants rated the perceived difficulty as “extremely easy” or 0.

Discussion:

The data from this study is the first to address optotype size for vestibular exercises in those who wear glasses. In subjects who do not have a vestibular disorder, optotype size did not affect gaze compliance as all subjects were able to keep their eyes on the target during pitch plane movements. All subjects rated all exercises in font sizes 14-22 as extremely easy. A previous study by Hillman and colleagues reported no difference in difficulty for healthy controls focusing on an optotype between 12-20 point font in standing[10], however they did not include subjects who wore glasses. However, in the study by Hillman, subjects with a unilateral hypofunction had more errors

in correctly identifying the correct letter when the font size decreased incrementally [10].

For pitch plane movements, subjects must keep the object of interest in focus while moving through the different diopters in the lens. Bifocals use two diopters in a single lens and trifocals use three diopters [7]. Progressive lens users have an additional challenge in that progressive lenses do not have the same diopter at any point in the lens [7]. Several studies have linked the use of bifocal and trifocal lenses to increased fall risk [11-13], older adults more frequently use bifocal and trifocal lenses, older adults more frequently have vestibular disorders, and people with vestibular disorders have increased risk of falling [14]. To date, there is not strong evidence of the relationship between corrective lenses and the perception of dizziness in those with vestibular disorders.

The VestAid, as demonstrated in other studies, is a feasible method to attempt clinically quantify VOR impairments [3,9], and the Clinical Practice Guidelines on vestibular hypofunction and concussion/mild traumatic from the Academy of Neurologic Physical Therapy of the American Physical Therapy Association recommend VOR exercises in the pitch plane when needed for patients with vertical VOR deficits [2,15]. Neither of these documents suggests the size of the target to focus on or if glasses wearers should complete the activity with glasses on or off [2,15]. While this study shows that the optotype size on the VestAid app in healthy subjects with corrective lenses does not change performance, the next step is replicating this study with subjects experiencing dizziness. While the sample size of twelve is small, Moore et al. recommends that a sample size of 12 is appropriate for pilot studies [16]. Limitations to this study include only assessing VOR exercises in the pitch plane and only at one speed of head movement.

Future work should investigate what optotype size works optimally for those who use bifocals, trifocals or progressive lenses and are experiencing dizziness. Understanding if there is an ideal optotype size for VOR exercises will allow for personalized care to optimize function and promote recovery. In conclusion, optotype size on the VestAid app in healthy subjects with bifocals or blended lenses did not affect eye gaze accuracy in healthy persons during pitch head movements.

Table 1: Results from the VestAid device regarding head compliance and eye gaze stability for subjects completing vertical VORx1 exercises.

		Average Head Compliance	Average Eye Gaze Stability	Average Reported Difficulty*
Optotype size	Optotype size 22	100%	100%	0
	Optotype size 20	100%	100%	0
	Optotype size 18	100%	100%	0
	Optotype size 16	100%	100%	0
	Optotype size 14	100%	100%	0

*Reported difficulty rated on a 0-10 scale equivalent to “extremely easy” to “extremely hard”

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