• Clinical Research •

Diagnostic values of questionnaires of Convergence Insufficiency Symptom Survey and College of Optometrists Vision Development Quality of Life in the screening of convergence insufficiency

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Abstract

● **AIM:** To compare and analyse the diagnostic efficacy of the College of Optometrists Vision Development Quality of Life Questionnaire (COVD-QOL) and the Convergence Insufficiency Symptom Survey (CISS) in detecting convergence insufficiency and to compare their diagnostic value in clinical applications.

● **METHODS:** Using the diagnostic test method, 62 adult patients with convergence insufficiency (age: 24.74±3.75y) and 62 normal participants (age: 23.61±3.13y) who visited the Optometry Clinic of West China Hospital of Sichuan University from April 2021 to January 2023 were included. All subjects completed the CISS and COVD-QOL. Statistical analysis of the sensitivity and specificity of the CISS and COVD-QOL and comparison and joint experimental analysis of their diagnostic efficacy were performed.

● **RESULTS:** The sensitivity of the CISS and COVD-QOL for convergence insufficiency was 64.5% and 71.0%, respectively, while the specificity was 96.8% and 67.7%, respectively. Compared to the CISS alone, the combination of the CISS and COVD-QOL demonstrated lower sensitivity and specificity. The areas under the receiver operating characteristic curve of CISS, COVD-QOL and CISS combined with COVD-QOL were 0.806, 0.694 and 0.782, respectively.

● **CONCLUSION:** Considering the low sensitivity of the CISS and the low specificity of the COVD-QOL, it is recommended to supplement these questionnaires with other screening tests for the detection of convergence insufficiency.

● **KEYWORDS:** convergence insufficiency symptom survey; College of Optometrists Vision Development Quality of Life Questionnaire; convergence insufficiency; asthenopia

INTRODUCTION

Convergence insufficiency describes the inability or weakness of the fusional convergence system to maintain normal binocular vision at near, which is the most common nonstrabismic binocular visual dysfunction[1-2]. The incidence of convergence insufficiency in the general population is approximately 3.4%–17.6%[2-4]. The incidence of under aggregation in the general population and military personnel after brain trauma is 42%–43% and 23%–46%, respectively[5]. Common symptoms of convergence insufficiency include eye fatigue, eye pain, diplopia, blurred vision, dizziness, and difficulty in focusing[2,6-7]. Convergence insufficiency has a high risk, especially for high-intensity reading groups such as students, which has a serious negative impact on life, study, and work[8-11].

Accommodative and binocular vision functions are often used to diagnose convergence insufficiency in the clinic, but this examination is time-consuming, and the examination process is relatively complicated, so the examiner needs certain professional knowledge of ophthalmology and optometry[2,12]. Therefore, it is challenging to implement this objective

examination program in schools with limited resources for visual function screening and medical conditions. Therefore, it is important to use convenient and effective questionnaire tools to provide faster and more reliable screening through simple referral criteria.

Clinically commonly used questionnaires for the assessment of undercollection include the Convergence Insufficiency Symptom Survey (CISS) and the College of Optometrists in Vision Development Quality of Life Questionnaire (COVD-QOL)[3,13-17]. The CISS is mainly used to assess the clinical symptoms of convergence insufficiency subjective questionnaires[18-19]. The COVD-QOL was designed by Maples and Bither[20] and was used to assess the subjective symptoms of binocular visual abnormalities. The scoring method was similar to that of the CISS. The former is mostly used for the study of convergence insufficiency, while the latter can reflect the effects of multiple factors on visual functions, such as accommodative and convergence ability, eye movement and visual information processing ability, both of which have good reliability and validity[21]. Although both are widely used for the assessment of binocular vision dysfunctions, they are not used for the screening assessment of convergence insufficiency, and there is no conclusion on their applicability, sensitivity, and specificity in China.

Therefore, this study mainly explored the diagnostic efficacy of the CISS and COVD-QOL for convergence insufficiency and compared the sensitivity and specificity of the two tools. Therefore, we explored the detection efficiency of convergence insufficiency with the CISS and COVD-QOL to provide a reference for population convergence insufficiency screening.

SUBJECTS AND METHODS

Ethical Approval This diagnostic test study was performed in the Optometry Clinic of West China Hospital from April 2021 to January 2023. A total of 62 cases (aged 24.74±3.75y) of adult patients with convergence insufficiency and 62 cases (aged 23.61±3.13y) of normal subjects were enrolled. All participants signed informed consent forms. This study was approved by the Ethics Committee of the West China Hospital [No.268 (2021)] and complied with the Declaration of Helsinki.

The diagnostic criteria for undercollection established by some scholars, such as the Convergence Insufficiency Treatment Trial Group[10], were used as the golden standard for undercollection diagnosis, namely, 1) near exophoria at least 4 degree of prism (△) greater than distance exophoria; 2) reduced near positive fusional vergence (break point ≤15△ or failed Sheard's criterion); 3) near point of convergence break point ≥6 cm. The diagnostic criteria for the normal subjects were as follows: 1) best corrected visual acuity of both eyes

≥0.8 (decimal record method); 2) normal accommodative and binocular visual functions; 3) near point of convergence <6 cm. The inclusion criteria of subjects in the two groups were as follows: 1) aged 18–35 years old, no gender limitation; 2) best corrected visual acuity of both eyes ≥0.8 (decimal record method). Exclusion criteria: 1) organic diseases of the eye, strabismus, and systemic diseases; 2) neuromental diseases, brain trauma, brain surgery, *etc*.

Accommodative and Binocular Vision All patients underwent intraocular pressure examination, ocular surface anterior segment examination under a slit lamp, and fundus examination. All patients underwent subjective refraction and binocular visual function examination under the condition of optimal refractive correction, including far/near horizontal heterophoria, accommodation convergence/accommodation, far/near fusional vergence, positive/negative relative accommodation, accommodative amplitude, near point of convergence, accommodative response, and accommodation facility.

Questionnaire Subjects were instructed to complete the self-assessment of the COVD-QOL and CISS following completion of routine examinations, accommodation, and binocular function tests.

The CISS was used to assess visual symptoms. The CISS consists of 15 items, with a total score of 60. Patients answered the questionnaire with a frequency of never (0 points), occasionally (1 point), sometimes (2 points), often (3 points), and always (4 points). A higher score indicates more serious symptoms. A total score of ≥21 points for adults is clinically significant[18].

The COVD-QOL had a total of 19 items. The subjects answered all the items with the frequency of never (0 points), very few (1 point), occasionally (2 points), often (3 points) and always (4 points) to describe the symptoms. The final sum was the total scale score of 76. A total score >20 points was considered to indicate possible visual abnormalities[21].

Statistical Analysis SPSS 23.0 statistical software was used for statistical analysis. Measurement data are expressed as the mean and standard deviation, and enumeration data are expressed as the frequency and percentage. Independent-samples t tests were used to compare the age and binocular vision results of the two groups, and χ^2 tests were used to compare gender. The four-grid table was used to compare the diagnostic tests with the gold standard to calculate the sensitivity and specificity of each diagnostic test, and receiver operating characteristic (ROC) curves were used to analyse the diagnostic efficacy of the CISS, COVD-QOL, and CISS combined with COVD-QOL as a screening tool. $P<0.05$ indicated that the difference was statistically significant.

Table 1 Comparison of demographic data and binocular vision results between the two groups

Project	Convergence insufficiency group (*n*=62)	Normal group (*n*=62)	*t* or χ^2	*P*
Gender (male/female)	28/34	23/39	0.833	0.362
Age (y)	24.74±3.75	23.61±3.13	-1.817	0.074
Spherical equivalent (right eye only, D)	-2.96±1.85	-3.21±1.83	-0.751	0.996
Near horizontal heterophoria ($^\Delta$)	-11.88±4.61	-1.92±3.05	0.990	0.322
Near point of convergence (cm)	7.31±2.29	4.09±0.91	16.875	<0.001[a]
Near positive fusional vergence ($^\Delta$)	17.57±7.23	25.02±6.14	1.027	0.313
stereopsis (")	35.23±26.91	31.86±18.63	0.869	0.353
Accommodative amplitude (right eye only, D)	9.98±1.71	10.85±1.56	1.410	0.237
Accommodation facility (right eye only, cpm)	10.82±4.50	13.10±2.38	17.545	<0.001[a]
Positive relative accommodation (D)	-2.67±1.07	-2.98±0.81	5.927	0.016[a]
Negative relative accommodation (D)	1.78±0.43	2.01±0.31	3.863	0.052
CISS score	24.95±11.81	11.42±5.79	-8.098	<0.001[a]
COVD-QOL score	26.89±11.77	15.53±7.99	-6.285	0.009[a]

[a]*P*<0.05; D: Diopter; $^\Delta$: Degree of prism; cpm: Circle per minute; ": Seconds of arc; CISS: Convergence Insufficiency Symptom Survey; COVD-QOL: College of Optometrists Vision Development Quality of Life Questionnaire.

Table 2 Comparison of sensitivity and specificity of the CISS and COVD-QOL in the diagnosis of convergence insufficiency

Golden standard	CISS		COVD-QOL	
	Normal	Convergence insufficiency	Normal	Convergence insufficiency
Normal	60	2	42	20
Convergence insufficiency	22	40	18	44
Sensitivity	64.5%		71.0%	
Specificity	96.8%		67.7%	

CISS: Convergence Insufficiency Symptom Survey; COVD-QOL: College of Optometrists Vision Development Quality of Life Questionnaire.

Table 3 Sensitivity and specificity analysis of the CISS combined with the COVD-QOL in the diagnosis of convergence insufficiency

Golden standard	CISS combined with COVD-QOL		Sensitivity	Specificity
	Normal	Convergence insufficiency		
Normal	59	3	61.3%	95.2%
Convergence insufficiency	24	38		

CISS: Convergence Insufficiency Symptom Survey; COVD-QOL: College of Optometrists Vision Development Quality of Life Questionnaire.

RESULTS

Demographic and Clinical Characteristics of the Subjects in the Two Groups A total of 62 cases (aged 24.74±3.75y) of adult patients with convergence insufficiency and 62 cases (aged 23.61±3.13y) of normal subjects were included. In the convergence insufficiency group, there were 28 males and 34 females. There were 23 males and 39 females in the normal group. There was no significant difference in sex, age or spherical equivalent between the two groups (*P*>0.05). There were statistically significant differences in near horizontal heterophoria (*P*<0.001), right eye accommodative facility (*P*<0.001), positive relative accommodation (*P*=0.016), CISS score (*P*<0.001) and COVD-QOL score (*P*=0.009; Table 1).

Analysis of Sensitivity and Specificity of the CISS and COVD-QOL Among the 62 patients with convergence insufficiency and 62 normal subjects diagnosed based on the gold standard, the sensitivity, specificity and CISS and COVD-QOL were 64.5% and 71.0%, 96.8% and 67.7%, respectively (Table 2).

ROC Curve Analysis of the CISS, COVD-QOL, and CISS Combined with the COVD-QOL for the Diagnosis of Convergence Insufficiency Since both the CISS and COVD-QOL had low sensitivity, the total score of the CISS and the total score of the COVD-QOL were added in the present study to obtain the joint total score of the two questionnaires, and the cut-off value of the joint total score of the two questionnaires was 44.5 points according to the ROC curve. The sensitivity of the combined total score of the two questionnaires was 61.3%, and the specificity was 95.2%, as shown in Table 3.

The areas under the curve of the CISS, COVD-QOL and combination of the CISS and COVD-QOL were 0.806, 0.694 and 0.782, respectively. The CISS had better recognition ability for convergence insufficiency than the COVD-QOL and the CISS combined with the COVD-QOL (Figure 1).
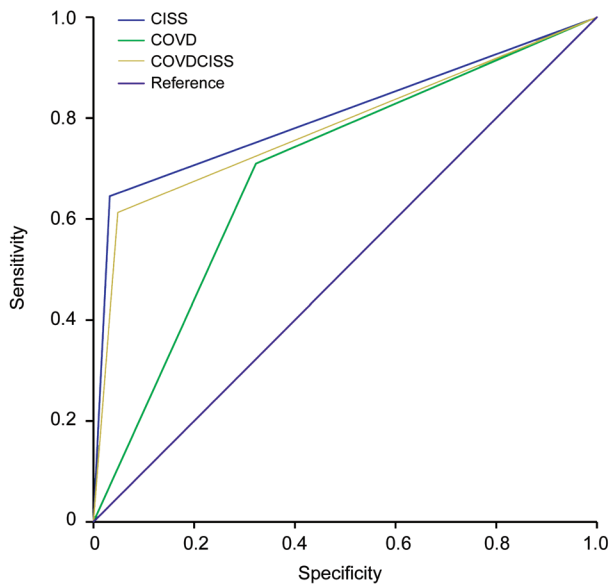
Figure 1 Receiver operating characteristic curve analysis of the CISS, COVD-QOL and CISS combined with the COVD-QOL CISS: Convergence insufficiency symptom survey; COVD-QOL: College of Optometrists vision development quality of life questionnaire.

DISCUSSION

With the popularity of video terminals and the acceleration of the pace of work, visual demand has far exceeded the load, and the incidence of convergence insufficiency is rising year by year[22-25]. Patients with convergence insufficiency often complain about such asthenopia symptoms as dry and uncomfortable eyes, ocular pain, diplopia, headache, and blurred vision[6-7], thus seriously affecting their normal work and life. The evaluation population in this study was patients with convergence insufficiency in general hospitals. The evaluation direction of this study focused on the applicability of the CISS and COVD-QOL in China. The results could provide a reference for optometrists or ophthalmologists to use the CISS and COVD-QOL. Given the low sensitivity of the CISS and the low specificity of the COVD-QOL, it is recommended that in addition to these questionnaires, other screening tests are performed to screen for convergence insufficiency.

In this study, the sensitivity and specificity of the CISS in the diagnosis of adult convergence insufficiency were 64.5% and 96.8%, respectively. In the research by Horwood *et al*[26], the CISS was found to have a sensitivity of 38% and a specificity of 77% in the diagnosis of convergence insufficiency. This is different from the results of this study. The reasons for the inconsistent results between the two studies may be as follows: first, there are differences in the populations included in the two studies. Second, the CISS is a subjective questionnaire, and the scores of the examination results are determined by the subjective will of the subjects, with certain error.

A diagnostic test of convergence insufficiency was conducted on the COVD-QOL. The results showed that although its sensitivity was slightly higher than that of the CISS, its specificity was worse. It may be that the COVD-QOL has a wide application range, which not only reflects the relationship between accommodation and convergence but also reflects the impact of eye movement, visual information processing ability and other factors on visual function[11,27-28]. The wide application range reduces the specificity of the COVD-QOL for the diagnosis of convergence insufficiency.

Since both the CISS and the COVD-QOL had low sensitivity for the screening of convergence insufficiency, in this study, the total CISS score and the total COVD-QOL score were added to obtain the combined total score, and the cut-off value of the combined total score was 44.5 points according to the ROC curve. However, the sensitivity of the CISS combined with the COVD-QOL was only 61.3%. The specificity was 95.2%. ROC curve analysis can provide more comprehensive evaluation information for diagnostic or screening tools. Therefore, in this study, the CISS, the COVD-QOL, and the CISS combined with the COVD-QOL in the diagnosis of convergence insufficiency were analysed by ROC curve analysis. The results showed that the areas under the ROC curve of the three questionnaires were 0.806, 0.694, and 0.782, respectively. The areas under the ROC curve of the CISS were higher than those of the COVD-QOL and the CISS combined with the COVD-QOL. Therefore, the CISS outperformed the COVD-QOL and the CISS combined with the COVD-QOL in identifying convergence insufficiency. Although the diagnosis of convergence insufficiency by the CISS is not particularly ideal, it is still the best questionnaire tool for screening for convergence insufficiency.

In summary, although the sensitivity of the COVD-QOL to diagnose an insufficient set was better than that of the CISS, its specificity was worse than that of the CISS. The combined application of the two does not improve the diagnostic efficiency. Although the diagnosis of convergence insufficiency by the CISS is not ideal, it is also the best questionnaire tool to screen for convergence insufficiency.

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