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CLINICAL INVESTIGATIONS

Motion Perception Tested With Reversing Grating in Duane's Syndrome

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Abstract: Many papers have reported that motion perception asymmetry (MPA) is replaced by motion perception symmetry (MPS) by the 4th to 5th month after birth, when stereopsis starts to occur in normal infants. Duane's syndrome is a congenital motor abnormality, it does, however, reportedly show good stereopsis. We confirmed the stereopsis in Duane's syndrome and checked the motion perception (MP) by using the Reversing Grating Test to investigate if the congenital motor abnormality affects the MP in patients whose binocular sensory system is well developed. Thirty-eight Duane's syndrome patients aged 3 to 45 years were included in the present study. They were divided into 24 cases of Duane I, 9 cases of Duane II, 5 cases of Duane III. The Titmus Stereo Tests, Lang Stereotest, and TV-Random Dot Stereo Test were used to examine the stereopsis. Thirty-four patients had good stereopsis, and 4 had poor stereopsis. None of them showed MPA in any spatial frequencies (1/4, 1/2, 1 cycles/degree) examined. The Reversing Grating Test is useful for examining MPA in strabismus patients with eye movement limitations. **Jpn J Ophthalmol 1998;42:199–203**

Key Words: Duane's syndrome, motion perception asymmetry (MPA), motion perception symmetry (MPS), Reversing Grating Test.

Introduction

Many papers have reported that motion perception asymmetry (MPA) is replaced by motion perception symmetry (MPS) by the 4th or 5th month of life, when stereopsis starts to occur in normal infants.[1,2,3] It has been also reported that MPA is sustained in patients with early onset esotropia without good stereopsis, and a close relationship between MPA and stereopsis development has been suggested.

Duane's syndrome is a congenital motor abnormality, it does, however, reportedly show good stereopsis.[4,5] We confirmed the stereopsis in Duane's syndrome and checked the motion perception (MP) using the Reversing Grating Test[6] to investigate if the congenital motor abnormality affects MP in patients whose binocular sensory system is well developed.

Materials and Methods

We studied 38 patients with Duane's syndrome aged between 3 and 45 years. We examined the visual acuity, ocular deviation, stereopsis, and MP (Tables 1–3). We classified Duane's syndrome into three types; Duane I, II, and III, by the conventional classification reported by Huber[7] and Maruo et al[8] (Tables 4–6). Nine of the 38 patients undergone surgery before MP examination.

One cycle/degree (c/d) drifting gratings right and left, and 1/4, 1/2, 1 c/d reversing gratings were presented on the screen of IBM personal system/2 at a distance of 30 or 60 cm.

The testing procedure is followed by the instructions of Wang et al.[6]

1. Occlude the left eye (LE): We observe the optokinetic nystagmus (OKN) induced by drifting gratings in order to confirm OKN can be induced in the right eye (RE).
2. Occlude RE: The same procedure as step 1.
3. Occlude LE: We show 1/4, 1/2, 1 c/d reversing gratings and ask the patient the drifting direction. At the same time, we observe if there is any nystagmus.

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Table 1. Ophthalmological Findings and Results in Cases With Duane I (24 Cases)

Cases	Sex	Age (y)	Eye	Type	Visual Acuity	Ocular Deviation	Stereopsis	MPA
1	M	3	L	I	R:1.2 (n.c.) L:1.2 (n.c.)	Ortho	L: all passed	(—)
2	M	5	L	I	R:1.0 (n.c.) L:1.2 (n.c.)	Ortho	T L: all passed	(—)
3	F	5	Bil	I	R:1.0 (n.c.) L:1.2 (n.c.)	Ortho	L: all passed	(—)
4	F	6	L	I	R:1.5 (n.c.) L:1.0 (n.c.)	Ortho	T: F(+) A(3/3) C(9/9) L: all passed	(—)
5	F	8	L	I	R:2.0 (n.c.) L:2.0 (n.c.)	Ortho	T L: all passed	(—)
6	F	8	L	I	R:1.5 (n.c.) L:1.5 (n.c.)	Ortho	T L: all passed	(—)
7	F	9	L	I	R:2.0 (n.c.) L:2.0 (n.c.)	Ortho	T L: all passed	(—)
8	F	9	L	I	R:1.5 (n.c.) L:1.5 (n.c.)	Ortho	T L: all passed	(—)
9	F	9	L	I	R:2.0 (n.c.) L:2.0 (n.c.)	Ortho	T L: all passed	(—)
10	F	9	R	I	R:0.15 ($1.2\times-6.00_D-1.75_D$ Ax100°) L:0.4 ($1.0\times-7.00_D$cyl-0.75_D Ax120°)	Ortho	T L: all passed	(—)
11	F	9	L	I	R:1.5 (n.c.) L:0.8 ($1.0\times$cyl-0.50_D Ax100°)	Ortho	T L: all passed	(—)
12	M	10	L	I	R:2.0 (n.c.) L:2.0 (n.c.)	Ortho	T L: all passed	(—)
13	M	10	L	I	R:1.5 (n.c.) L:1.5 (n.c.)	Ortho	T L: all passed	(—)
14	F	11	L	I	R:1.2 (n.c.) L:1.2 (n.c.)	X	T L: all passed	(—)
15	M	11	R	I	R:0.07 ($1.2\times-5.50_D$) L:0.07 ($1.2\times-6.00_D$cyl-1.00_DAx115°)	Ortho	T: F(+) A(3/3) C(8/9) L: all passed	(—)
16	M	13	L	I	R:0.2 ($1.2\times-2.00_D$) L:0.2 ($1.2\times-2.50_D$)	Ortho	T: F(+) A(3/3) C(6/9) L: all passed	(—)
17	M	13	L	I	R:0.9 ($1.5\times-1.00_D$) L:1.2 (n.c.)	Ortho	T L: all passed	(—)
18	F	13	L	I	R:2.0 (n.c.) L:2.0 (n.c.)	Ortho	T L: all passed	(—)
19	M	20	Bil	I	R:1.5 ($1.5\times+1.25_D$) L:1.5 ($1.2\times+3.25_D$cyl-0.50_DAx10°)	Ortho	T L: all passed	(—)
20	M	25	R	I	R:0.3 ($1.2\times-2.50_D$cyl-0.25_DAx100°) L:0.2 ($1.5\times-3.50_D$)	Ortho	T L: all passed	(—)
21	F	33	R	I	R:0.6 ($1.2\times-1.25_D$) L:0.5 ($1.2\times-1.25_D$)	Ortho	T L: all passed	(—)
22	M	7	L	I	R:1.0 (n.c.) L:1.0 (n.c.)	Ortho	*TV-Stereo: C_8(+)	(—)
23	F	11	L	I	R:2.0 (n.c.) L:0.3 ($1.2\times+2.25_D$)	Ortho	T: F(+) A(3/3) C(4/9) L: all passed	(—)
24	M	17	L	I	R:1.0 (n.c.) L:1.0 (n.c.)	Ortho	T: F(−) A(1/3) C(0/9) L: Cat (−) Star (−) Car (+)	(—)

MPA: motion perception asymmetry. Ortho: orthophoria. X: exophoria. *TV-Stereo: C_8(+) means 1225" stereopsis.
Titmus (T) all passed: Fly (+) Animal (3/3) Circle (9/9).
Lang (L) all passed: Cat (+) Star(+) Car(+).

After some time, we ask the patient, "Is it just flickering or drifting? If drifting, what is the direction?"

4. Occlude RE: The same procedure as step 3.
5. We show reversing gratings and alternately occlude each eye. If the RE sees left drifting, then we occlude the RE. If the LE keeps the feeling of left drifting (right beating nystagmus), this response is evaluated as MPS. If the LE feels right

Table 2. Ophthalmological Findings and Results in Cases With Duane II (9 Cases)

Cases	Sex	Age (y)	Eye	Type	Visual Acuity	Ocular Deviation	Stereopsis	MPA
25	M	9	R	II	R:0.5 (1.5×−2.00$_D$) L:0.7 (1.5×−1.50$_D$)	X	T L: all passed	(—)
26	M	11	L	II	R:2.0 (n.c.) L:2.0 (n.c.)	X(T)	T L: all passed	(—)
27	M	33	L	II	R:0.9 (1.5×−1.50$_D$) L:1.5 (n.c.)	XT.LHT	T: F(+) A(3/3) C(7/9) L: all passed	(—)
28	F	16	L	II	R:1.5 (n.c.) L:2.0 (n.c.)	X.RH	T: F(+) A(3/3) C(6/9) L: all failed	(—)
29	M	18	R	II	R:(0.5×−4.00$_D$) (n.c.) L:(0.6×−4.00$_D$cyl-1.00$_D$Ax120°)	N: XT D: Ortho	T:F(−) A(0/3) C(0/9) L: all passed	(—)
30	F	25	L	II	R:1.5 (n.c.) L:1.5 (n.c.)	XT.LHT	T:F(+) A(3/3) C(6/9) L: Cat (−) Star (+) Car (±)	(—)
31	M	39	R	II	R:1.5 (n.c.) L:(1.5×−4.50$_D$)	XT	T: F(+) A(0/3) C(1/9) L: all passed	(—)
32	F	45	L	II	R:0.1 (1.0×−5.00$_D$) L:0.15 (1.2×−5.00$_D$)	X(T), RH	T: F(+) A(3/3) C(4/9) L: all passed	(—)
33	F	17	L	II	R:(1.0×−2.75$_D$) L:(1.0×cyl+1.25$_D$Ax30°)	XT	T:F(±) A(0/3) C(4/9) L: Cat (−) Star (−) Car (±)	(—)

MPA: motion perception asymmetry. X: exophoria. X(T): intermittent exotropia. XT: exotropia. LHT: left hypertropia. RH: right hyperphoria, N: near. D: distant.
Titmus (T) all passed: Fly(+) Animal (3/3) Circle (9/9).
Lang (L) all passed: Cat (+) Star(+) Car(+).

drifting, we change the occlusion several times to confirm the patient's MPA.

Patients were tested for the stereopsis by the Titmus Stereo Tests, Lang Stereotest or TV-Random Dot Stereo Test.[9] The passing score of the Titmus Stereo Tests was Circle No. 5 (100 seconds of arc) or better, and that of the Lang Stereotest was all three correct answers. If there was any discrepancy in results between the Titmus Stereo Tests and Lang Stereotest, we chose the better of the two. We examined visual acuity, stereopsis, and ocular deviation on the day we examined MP.

Results

Results are shown in Tables 1–3. Thirty-eight patients, 18 male and 20 female, were examined. They

Table 3. Ophthalmological Findings and Results in Cases With Duane III (5 Cases)

Cases	Sex	Age (y)	Eye	Type	Visual Acuity	Ocular Deviation	Stereopsis	MPA
34	M	23	L	III	R:1.5 (n.c.) L:1.2 (n.c.)	XT	T: F(+) A(3/3) C(6/9) L: all passed	(—)
35	M	32	Bil	III	R:1.5 (n.c.) L:0.3 (1.5×−3.00$_D$)	ET.RH	T:F(±) A(3/3) C(2/9) L: all passed	(—)
36	F	11	Bil	III	R:(0.7×+4.00$_D$cyl+2.00$_D$Ax80°)(n.c.) L:(1.2×+6.50$_D$cyl−1.50$_D$Ax180°)	N:XT D:Ortho	T: F(±) A(3/3) C(3/9) L: all failed	(—)
37	F	40	R	III	R:0.4 (0.7×+0.50$_D$cyl−1.75$_D$Ax170°)(n.c.) L:0.9 (1.0×−0.25$_D$)	XT. RHT	T L: all failed	(—)
38	F	33	R* L	III I	R:1.5 (n.c.) L:1.2 (n.c.)	XT	T:F(−) A(0/3) C(1/9) L: all passed	(—)

MPA: motion perception asymmetry. XT: exotropia. ET: esotropia. RH: right hyperphoria. N: near. D: distant. Ortho: orthophoria. RHT: right hypertropia.
Titmus (T) all passed: Fly(+) Animal (3/3) Circle (9/9).
Lang (L) all passed: Cat (+) Star(+) Car(+).
*Case 38 was classified as Duane III in Tables 4 and 6.

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Table 4. The Stereopsis and the Motion Perception Asymmetry (MPA) in Duane I (24 Cases)

	Stereopsis		
MPA	(+)	(−)	Total
(+)	0	0	0
(−)	23	1	24
Total	23	1	24

Table 5. The Stereopsis and the Motion Perception Asymmetry (MPA) in Duane II (9 Cases)

	Stereopsis		
MPA	(+)	(−)	Total
(+)	0	0	0
(−)	8	1	9
Total	8	1	9

were divided into Duane I (n = 24), Duane II (n = 9), and Duane III (n = 5). Case 38, with Duane III in the right eye and Duane I in the left eye, was classified as Duane III.

Bilateral eyes were affected in five cases, and monocular eye was affected in 33 cases. Eight right eyes and 25 left eyes were affected in monocular cases.

None of the patients had MPA. Results of the stereopsis and the MP divided into three types are shown in Tables 4–6. Twenty-four cases of Duane I were divided into 23 cases with the stereopsis(+) and the MPA(−), and 1 case with the stereopsis(−) and the MPA(−) (Table 4).

Nine cases of Duane II were divided into eight cases with the stereopsis(+), the MPA(−), and 1 case with the stereopsis(−) and the MPA(−) (Table 5).

Five cases of Duane III were divided into three cases with the stereopsis(+), the MPA(−), and two cases with the stereopsis(−) and the MPA(−) (Table 6).

Though Case 22 was 7 years old, he had slight mental retardation and could speak only a little, and thus we could not examine stereopsis by the Titmus Stereo Tests and Lang Stereotest, but we did confirm a stereo acuity of 1225" by using the TV-Random Dot Stereo Test. Case 23, who passed Circle No. 4 in the Titmus Stereo Tests, passed the Lang Stereotest and Circle (7/9) in her previous test. Case 27, who had exotropia (XT) and left hypertropia (LHT), showed good stereopsis in 20° levoversion. Though Case 34 had XT, he showed good stereopsis when he turned his face to the right and depressed his chin. They had well-compensated head postures where they showed good stereopsis.

There were differences between the results on the Titmus Stereo Tests and Lang Stereotest in Cases 28, 29, 30, 31, 32, 35 and 38, and we evaluated the stereopsis by the better result of the two. Though Cases 29 and 32 could not respond "car," "star," or "cat," they could point exactly to the places where those figures appeared. We judged that they passed the Lang Stereotest. Patients can look at the Lang Stereotest without glasses in a more natural condition than the Titmus Stereo Tests.

Cases 24, 33, 36, and 37 had poor stereopsis. In Case 24, there had been an evident difference in visual acuity between the two eyes (RE visual acuity: 1.2, and LE visual acuity: 0.5) until 7 years of age, and stereopsis did not develop well due to the difference in visual acuity. Though he was 17 years old when he was examined, he showed crowding phenomenon in the left eye. We examined his visual acuity by using the single test charts.

Discussion

Niki et al[4] investigated the stereopsis by the Titmus Stereo Tests in 100 cases of Duane's syndrome. Eighty-nine cases were successfully examined, and 55 of the 89 (61.8%) cases passed the Titmus Stereo Tests Circle No. 5 or higher. Tani et al[5] studied the stereopsis by the same test in 23 cases of Duane's syndrome. Nineteen cases were able to be tested, and 14 cases (73.7%) passed the Circle No. 5 or higher. We examined stereopsis in 38 cases. Thirty-five cases were tested by the Titmus Stereo Tests, and 25 cases (71.4%) passed the Circle No. 5 or higher. This result is similar to the previous reports.[4,5]

Tychsen et al,[10] Demer et al,[11] Norcia et al,[2] and many other authors[12–18] reported that MPA remained in patients with early onset esotropia, which appeared within 6 months after birth. One of the authors (Uno) investigated the relationship of MPA and time of the onset of esotropia by using the Reversing Grating Test, and reported that there was a significant correlation between MPA and time of the onset of esotropia.[19]

Table 6. The Stereopsis and the Motion Perception Asymmetry (MPA) in Duane III (5 Cases)

	Stereopsis		
MPA	(+)	(−)	Total
(+)	0	0	0
(−)	3	2	5
Total	3	2	5

There are some articles about MP in Duane's syndrome. Gross et al[20] reported that two Duane's syndrome type I patients had MPA. In their report, pursuit movements were assessed by asking patients to track a small target moving nasally and temporally, OKN was generated using a full-field OKN drum, eye position was recorded, and eye velocity to target velocity was calculated using electro-oculography and a digital computer. We suspect that they may estimate "the MPA-like movement" due to eye movement limitations in Duane's syndrome as MPA. Though the electro-oculogram (EOG) had been used to record and analyze the MP, it is necessary to consider the subjective perception of flickering during the test in cases with limitation of eye movements, as with Duane's syndrome. We were able to get reliable, subjective responses in those cases who did not show OKN objectively, and to estimate MP. The Reversing Grating Test is very helpful in determining MP in strabismus patients with limitation of eye movements.

In this study, 34 of the 38 cases showed good stereopsis. Stereopsis was likely to develop in certain positions of gaze by turning their faces.

It is interesting that all cases of Duane's syndrome, which is a congenital motor abnormality, were MPA(−). One possible explanation may be the different central mechanism regulating MP and Duane's syndrome. Tychsen et al[16] speculated that MPA is related to the middle temporal visual area, a higher visual area. If the motor abnormality in Duane's syndrome is related to a more peripheral (subcortical) mechanism, the normal motion perception results in this syndrome are understandable.

Conclusion

We examined 38 Duane's syndrome patients aged 3 to 45 years. None of them showed MPA in any spatial frequencies (1/4, 1/2, 1 c/d) examined. The Reversing Grating Test is useful in examining the MPA in strabismus patients with eye movement limitations.

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