Acta orthop. scand. *50*, 771–775, 1979

POSTURAL EFFECTS ON NYSTAGMUS RESPONSE DURING CALORIC LABYRINTHINE STIMULATION IN PATIENTS WITH ADOLESCENT IDIOPATHIC SCOLIOSIS

II. An Electro-Nystagmographic Study

TAGE SAHLSTREND & BJÖRN PETRUSON

Departments of Orthopaedic Surgery I and Otorhinolaryngology, Sahlgren Hospital, University of Göteborg, Göteborg, Sweden.

An electro-nystagmographic study of postural effects on the nystagmus response has been performed in 40 patients with adolescent idiopathic scoliosis aged from 10 to 16 years. The control group comprised 29 healthy children of the same age. Caloric labyrinthine stimulation was done in the supine and erect position. The results were analysed with the aim of finding out whether an increased scoliotic deformity might influence the labyrinthine response. For comparison of the nystagmus response in the two different positions a quotient of the values (degrees/second) obtained from cold water stimulation in the erect and supine position was calculated. In the control children the labyrinthine response in erect posture was half of the response in supine posture.

In erect posture the scoliotic deformity increased. This obvious change in the spine did not increase the caloric response from the convex side labyrinth. The predominance of the convex side labyrinth observed in the supine position was thus not seen in the erect position.

The results of this study did not support the assumption that a postural deformity in the spine can influence a calorically induced labyrinthine response.

Key words: aetiology; electronystagmography; nystagmus; posture; scoliosis

Accepted 1.ii.79

In a previous study (Sahlstrand & Petruson 1979) it was found that right and left convex scoliotics had significantly different patterns of response in caloric tests of vestibular function. The patients with the convexity to the right had a predominant sensitivity in the right labyrinth and the left convex patients had a predominant sensitivity in the left labyrinth. Thus, there seemed to be a clear relationship between the convexity and the more dominant labyrinth. It was difficult, however, to draw any conclusions as to whether this asymmetry was a causative factor in relation to the idiopathic curvature or whether it might be a feed-back effect from the deformed spine.

Caloric stimulation of the labyrinth is usually done in the supine position. After vestibular stimulation in erect posture there is a decreased response on both sides which can be explained by the orientation of the affective semicircular canal with response to the gravity vector (Proctor 1975). A scoliotic patient becomes more deformed in the spine

0001–6470/79/060771–05$02.50/0

when changing from the supine to the erect position. We do not know of any other asymmetric change that occurs when the patient alters his posture. In this study caloric vestibular stimulation has been performed in the supine and erect positions in an attempt to find out whether a change in posture influences the vestibular response differently in scoliotics compared to controls. This might be due to a changed asymmetry in the trunk and an altered asymmetric postural tone in the spine.

METHODS

The procedure for the investigation in supine posture has been described in detail in a previous paper (Sahlstrand & Petruson 1979). After the subjects had been stimulated in the supine position an interval of at least 1 hour was allowed before stimulation in the erect position. After this period none of the tested subjects had vertigo or nausea.

The recording was performed with the subject standing on a platform with his head straight forward, making the direction of the gaze horizontal, i.e. the horizontal semicircular canal was at an angle of about 30 degrees to the horizontal plane. The subjects had their eyes closed. If the subject experienced a strong instability during the stimulation he could support himself with his hands against a surrounding barrier.

The Mingograph was calibrated before the ENG in erect posture was begun. The syringing was done first in the left ear and then in the right ear for 30 seconds with cold water (30°) and using a volume of 100 cm^3. Registration of nystagmus started simultaneously with the syringing and was continued for 210 seconds. The time interval between the syringing was 10 minutes.

Nystagmus was analysed with regard to direction and maximum intensity.

The following variables were recorded during the tests:

I. Subjective reaction:
1) None
2) Vertigo
3) Vertigo + nausea
4) Vertigo + nausea + vomiting
5) Test interrupted because of severe subjective discomfort

II. Need for support:
1) One hand
2) Two hands
3) Not able to remain on the platform

III. Rotation:
1) None
2) Head
3) Head + shoulders
4) Head + shoulders + trunk

Regarding the direction of the rotation, no subject differed from the expected direction i.e. towards the stimulated side. All the subjects were also observed to have a lateral deviation of the body towards the stimulated side.

For comparison of the nystagmus response in the two different positions, we calculated a quotient of the values (degrees/second) obtained from the cold water stimulation in the erect and the supine position.

$$\frac{\text{stimulation erect}}{\text{stimulation supine}} \times 100\,\% = \text{quotient erect/supine}$$

In the statistical analysis Student's *t*-test and chi-square test have been used (Bailey 1973).

MATERIAL

This study included 40 children with adolescent idiopathic scoliosis (AIS), all of them with a single major structural curvature. The material has been described in a previous paper (Sahlstrand & Petruson 1979). Five patients from that study were not able to tolerate continued caloric stimulation in erect posture because of persisting vertigo or nausea after the caloric test in the supine position. One patient discontinued the study during stimulation of the right labyrinth in erect posture and one patient was excluded because the amplitude of the nystagmus reaction did not exceed 2 mm during left labyrinthine stimulation.

Eight scoliotics with double primary curvatures are included as a subgroup and are analysed separately. One further patient was excluded because of persisting vertigo and nausea after the caloric test in the supine position.

The control group comprised 29 children. From the controls presented in the original vestibular study one subject was excluded because the amplitude of the nystagmus did not exceed 2 mm during left labyrinthine stimulation.

RESULTS

There was no significant difference between the scoliotics and controls regarding the subjective reaction after calorisation in the

Table 1. Nystagmus response (degrees/second) in supine and erect posture. Mean values and standard errors of the means

	Supine		Erect	
	Right	Left	Right	Left
Right convex scoliotics	21.4 ± 1.3	18.7 ± 1.9	8.6 ± 1.0	7.5 ± 0.7
Placed under observation	22.4 ± 1.9	17.7 ± 2.8	9.2 ± 1.7	7.1 ± 0.6
Requiring treatment	20.8 ± 1.5	19.2 ± 2.1	8.3 ± 1.0	7.7 ± 0.8
Left convex scoliotics	20.5 ± 2.1	21.3 ± 2.2	13.2 ± 2.9	8.7 ± 1.3
Placed under observation	16.0 ± 2.5	16.9 ± 2.4	12.0 ± 3.0	8.7 ± 1.6
Requiring treatment	25.1 ± 2.1	25.7 ± 2.2	14.2 ± 3.1	8.8 ± 1.1
Double primary scoliotics	23.3 ± 5.1	19.6 ± 3.0	8.8 ± 0.7	7.6 ± 2.7
Controls	22.9 ± 2.2	19.7 ± 1.5	10.1 ± 0.9	9.2 ± 0.9

erect position. Neither did they differ regarding the visually estimated rotation effect. A need for support with one or two hands against the barrier was noted in nine of the patients and in one of the controls ($P < 0.05$).

Results in absolute values (degrees/second) and relative values (i.e. nystagmus quotient in per cent) are shown in Tables 1 and 2.

Table 2. The quotient of the values of nystagmus intensity in erect and supine posture. Mean values and standard errors of the means

	Right labyrinth stimulation %	Left labyrinth stimulation %
Right convex scoliotics	40 ± 4	50 ± 6
Placed under observation	40 ± 9	42 ± 4
Requiring treatment	40 ± 5	54 ± 8
Left convex scoliotics	67 ± 10	47 ± 7
Placed under observation	68 ± 12	63 ± 13
Requiring treatment	67 ± 17	33 ± 4
Double primary scoliotics	52 ± 7	45 ± 5
Controls	46 ± 3	50 ± 4

Nystagmus quotient in right labyrinthine stimulation

In the controls the quotient was 46 per cent. In the patients with right convex scoliosis the quotient was 40 per cent and in those with left convex scoliosis it was 67 per cent (Table 2). The statistical analysis showed a difference ($P < 0.05$) between controls and patients with left convex curvatures. The right convex scoliotics did not differ significantly from the controls but differed from the left convex scoliotics ($P < 0.05$).

Nystagmus quotient in left labyrinthine stimulation

In the control group the quotient was 50 per cent. In patients with right convex scoliosis the quotient was 50 per cent and in those with left convex scoliosis it was 47 per cent. There was no difference in the quotient between the controls and right and left convex scoliotics (Table 2).

When the patients were subgrouped the patients with left convex curvatures requiring treatment had a significantly ($P < 0.05$) lower quotient than the controls and the right convex scoliotics.

DISCUSSION

The aim of this investigation was to find answers to the following questions:

1. Does an increased lateral rotatory deformity of the spine influence the vestibular system?
2. Does vestibular dysfunction in some way contribute to idiopathic scoliosis?

In this study we have compared labyrinthine stimulation in the erect and supine position. In the controls the nystagmus response during vestibular stimulation in the erect position was half of the response in the supine position. This might be due to the change in position of the lateral semi-circular canal. The inclination from the horizontal plane is 30 degrees in the upright position compared to 60 degrees in the supine position with the head in anteflexion (Jongkees 1975).

When the patients change from the supine to the erect position the scoliotic deformity increases. This change might influence labyrinthine responses via spinovestibular pathways. In the right convex patients the quotient of the values of reactions in erect and supine position was 6 per cent lower than in the controls during stimulation of the right side (Table 2). This difference was not significant. After calorisation on the left side, i.e. the concave side, there was no difference at all. These results indicate that an erect posture and an increased right convex curvature did not influence the vestibular response after caloric stimulation.

In the left convex group patients requiring treatment had a significantly smaller quotient for left side stimulation. The patients only placed under observation had, as a group, a higher quotient because two patients had values above 100. These high quotients are difficult to explain. When the labyrinth on the concave side was stimulated there was a significantly larger quotient when all left scoliotics were compared to the controls. In the patients with left convex scoliosis the results of the vestibular stimulation were thus somewhat different from the right convex scoliotics.

From the results of this study and the findings from the previous study (Sahlstrand & Petruson 1979) we draw the following conclusions:

1. Such an obvious change in the spine as an increase in the deformity does not increase the quotient of the caloric response from the labyrinth on the convex side significantly. In the left convex patients requiring treatment, the quotient of the caloric response instead decreased significantly (Table 2).
2. There is a tendency towards a higher quotient for concave side labyrinthine stimulation in left convex patients. This difference between right and left convex scoliotic patients cannot be explained solely by the opposite direction of the scoliosis. The absolute values shown in Table 1 indicate that this tendency seemed to be explained by a higher concave side labyrinthine response in erect posture. This finding may indicate some facilitatory mechanism operating in left convex patients under these conditions.

To summarize, in the supine position the convex side labyrinth was predominant when the labyrinth was tested with cold and warm water. When the convex side was tested in erect posture with cold water this predominance was not observed. Thus, the increase in the scoliotic curvature in erect posture did not increase the predominance. This effect would have been expected if an idiopathic scoliosis were able to influence labyrinthine sensitivity. The results of this study, therefore, indicate that the differences in labyrinthine response observed in the previous study are more likely to be an effect of a primary vestibular imbalance. On the basis of such as assumption, and in view of the knowledge about the role vestibular spinal mechanisms have in postural control, the observed vestibular asymmetries might also be a contributory causative factor in adolescent idiopathic scoliosis.

ACKNOWLEDGEMENT

This investigation was supported by grants from: The Swedish Medical Research Council (Proj. B76–29X–04553–02), Greta och Einar Askers Stiftelse and Stiftelsen Sigurd och Elsa Goljes Minne.

REFERENCES

Bailey, N. T. J. (1973) *Statistical methods in biology*. Engl. Universities Press, London.

Jongkees, L. B. W. (1975) On the physiology and the examination of the vestibular labyrinths. *The vestibular system*, pp. 227–247, Ralph F. Naunthon, N.Y.

Proctor, L. R. (1975) Testing the vestibular system: Value of the caloric test. *The vestibular system*, pp. 249–260, Ralph F. Naunthon, N.Y.

Sahlstrand, T. & Petruson, B. (1979) A study of labyrinthine function in patients with adolescent idiopathic scoliosis. *Acta orthop. scand.* **50**, 759–769.

Correspondence to: Tage Sahlstrand, M.D., Department of Orthopaedic Surgery I, Sahlgren Hospital, University of Göteborg, S-413 45 Göteborg, Sweden.