Space Perception and Motor Behavior in Young Adults with Scoliosis

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Introduction

Idiopathic scoliosis (IS) is the most common type of scoliosis and affects girls more than boys during their teenage years. Genetic, musculoskeletal or neural abnormality or dysfunction were shown to be associated with IS. Patients with IS subjectively report having problems with spatial perception. Studies also showed that their motor behavior while walking was different from age-matched normal subjects. The relationship between visual spatial perception performance and motor behavior in patients with IS while walking is yet to be established. Understanding the relationship can clarify the speculation: Does the origin of this spinal derangement associate with central processing of spatial information? The present study is aimed to investigate the relationship between motor behavior and spatial perception in patients with IS and age-matched normal subjects.

Methods

Two groups of subjects, 30 IS and 30 age-matched adolescents, were recruited and measured of their motor behavior while standing and walking and of spatial perception performance. Motor behavior is measured by a foot-pressure measurement system which records the center of pressures (CoP). Amount of CoP sway is used to quantify motor behaviors while standing and individual foot CoP roll-over pattern is used to quantify motor behaviors while walking. Visual spatial perception is measured by line bisection test, bell cancellation and spatial relation part of Differential Aptitude Test (DAT). CoP sway is measured while patients were asked to stand at two postures (standard and tandem stance) for 30s each. Patients were asked to walk in comfortable speed while the CoP roll-over pattern was measured.

Results

Spatial Perception Performance

We found no significant difference between groups in line bisection test (0.224±0.11, 0.202±0.07, p=.38), significant difference between groups in bell cancellation test (number of omission in IS: 10.30±10.066, number of omission in controls: 4.97±5.436, p=.01) and DAT (Lower scores in IS than in normal controls, p=.04).

Motor Behavior Performance

Standing behaviors were measured by the following calculated include CoPa (area), CoPR (excursion), CoPAP (antero-posterior), CoPML (medial-lateral), CoPV (velocity). The parameters while subjects were standing with either of the four postures: shoulder wide stand (SWS), side by side stand (SSS), Tandem stand with left foot in the back (TDSL), tandem stand with right foot in the back (TDSR) and two eye conditions: open vs. close. We found that, no matter what posture or eye condition the subject were standing at, most of the parameters were statistical significant difference (p<.05) between IS and normal group, except CoPa in SWS with eye open and CoPa, CoPR, CoPAP in SWS with eye closed. The value of all balance parameters were higher in scoliosis group.

CoP Roll-over Pattern During Walking

The CoP roll-over pattern was divided into three parts during stance phase: 0-20% (hindfoot), 21-80% (midfoot), 81-100% (forefoot). The results showed that there were significant difference between two groups in CoPV, CoPV, CoPA of left foot and CoPV, CoPA of right foot in hindfoot-, CoPV, CoPA in left foot and CoPV, CoPV, CoPA in right foot were significant different in midfoot area between two groups. CoPV, CoPA in left foot and CoPV in right foot were significant different in forefoot area between two groups. The scoliosis group demonstrated lower values.

Discussion

The result indicated that the visual spatial perception in IS is comparably less efficient than in age-matched adolescent, indicating that the central operation for visual perception might be associated with the development of IS. The finding is in agreement with previous studies showing that IS might be cause by vestibular and visual-vestibular neural pathway impairments. [1] The other finding that IS sway significantly more than the control group is in line with several other studies, indicating that IS subjects are not able to automatized standing stability control, more voluntary effort and more energy cost is needed. [2] Our results further showed that the CoP roll-over pattern is different between IS and non-IS subject, indicating that the control of three rocker mechanism might be impaired. The possible explanation for these changes might be concomitant ankle-foot mechanism deviation in IS and/or change in central operation for gait control [3]. Thus, the walking efficiency in IS might be affected and intervention strategy might be needed.

Conclusions

The performance of spatial perception, standing stability and walking in IS is different from normal controls. IS might not be only a musculoskeletal problems but a problem associated with central operation deviation. Future studies are needed to clarify the role of central mechanism and ankle-foot mechanism in development of IS for development of intervention strategy other than surgical correction of spinal deformity.

Reference

