Preliminary study on the action of hypopressive gymnastics in the treatment of idiopathic scoliosis.

Marcel Caufrieza (a,b,c), Juan Carlos Fernández-Domínguez (d), and Nils Brynhildsvolle (e)

a Universidad de Castilla La Mancha, Toledo, Spain
b Laboratorio de Fisiología ocupacional y del entorno de la Comunidad francesa de Bélgica (HEPHS ISEK), Brussels, Belgium
c Université Libre de Bruxelles, Belgium
d Universitat de les Illes Balears, Palma de Mallorca, Spain
e Haute Ecole Charleroi Europe. Charleroi, Belgium

KEYWORDS Idiopathic scoliosis; Abdominal pressure; Physiotherapy; Radiology; Prevention

Cases description

To carry out this preliminary study we have recruited 3 children diagnosed with idiopathic scoliosis after their visit to the St Luc clinic pediatric orthopedic surgery in Brussels, and whose main characteristics are reflected on table 1.

Criteria for inclusion: between 8 and 15 years old, confirmed scoliosis evolutionary nature (aggravation of at least 5° in six months or 10° in a year) and gibbosity. Criteria for exclusion: congenital scoliosis, scoliosis located exclusively at lumbar level, lower scoliosis of 10° and over 40° Coob, history of vascular pathologies, associated neurological problems, or being simultaneous subjected to orthopedic treatments or any other physiotherapy treatment.

Overall evaluation

Parameters assessed for each of the 3 subjects:

Lateral deviation of the vertebrae. This has been measured through:

X-ray of the spinal column in anteroposterior projection standing: this deviation is measured in degrees via the Coob1 angle, formed by the extending lines from the scoliotic curve concavity side, the upper plate of the upper limit vertebrae and the lower plate of the lower limit vertebrae of said curve.

Plummet and measuring tape (to mark the vertical on the C7 spinous process that reaches the intergluteal fold): the distance from the S1 spinous process to said vertical marked by the plummet is measured in centimeters.

Rotation of the vertebrae: for its measurement, it has been used the same radiological study cited
above, and this has been valued through two different methods:
A special transparent rule called torsiometer (Perdriolle torsiometer) placed over the upper vertebra of the scoliotic curve and that measures the rotation of the pedicle movement in degrees (from the convexity toward the curve concavity) in relation to the total vertebrae surface, taking the vertebrae external edge at its lower third level as the limit.
The Nash and Moe method: measures in stadiums (from + to ++ + +) or degrees (from 1 to 4) the upper vertebra of the scoliotic curve convex side pedicle displacement degree in relation to the lateral edge and/or the vertebrae.

Deformation of the ribcage (or gibbosity). This variable is related to the vertebral rotation and constitutes a morphological measurement of said rotation.
For which measurement a scoliometer or cutaneous inclinometer has been used. This tool measures in degrees (with the help of a water level) the angle formed by the tangent to the zenithal points of the thoracic spine and the horizontal; that is to say, in base to the height difference from the more protuberant point of the gibbosity in relation to the concavity symmetric point.
The variables measurements have been performed prior to the treatment and 3 months later (that is to say, after the end of its application) and to avoid slants, they were carried out by the same evaluator.

Table 1 Epidemiological characteristics of the 3 cases included in the study

<table>
<thead>
<tr>
<th></th>
<th>Patient 1</th>
<th>Patient 2</th>
<th>Patient 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>13 years and 10 months</td>
<td>13 years and 9 months</td>
<td>10 years and 3 months</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>35</td>
<td>75</td>
<td>50</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>146</td>
<td>166</td>
<td>154</td>
</tr>
<tr>
<td>Sex</td>
<td>F</td>
<td>M</td>
<td>F</td>
</tr>
<tr>
<td>Curve type (Stagnara classification)</td>
<td>Right thoracolumbar (D6-L1)</td>
<td>Right thoracolumbar (D8-L2)</td>
<td>Right thoracic (D5-D11)</td>
</tr>
</tbody>
</table>

Planning and execution

The therapist providing the treatment was always the same one, which also contributed to avoid slants. We have carried out collective HG exercises 1 hour sessions, 3 times a week during 3 months.
As a complement to the collective sessions, the patients were subjected to one 30 minutes daily session of the same exercises over the rest of the week, but with fewer repetitions to be able to adjust to the duration (monitored through a "exercises diary").
The applied techniques are a group of postural exercises in which each position is maintained during 25s, with 3 repetitions of each exercise, and taking a break of at least 20 seconds between exercises.
Exercises description:

Exercise 1: orthostatic position with parallel feet and separated hip-distance. With the upper
limbs along the body, bending the elbows at a 90 degrees angle, flexing the wrists, extending and separating the fingers with their tips barely touching the iliac crests. Slightly bending the knees, bring forward the elbows without moving the hands and rotating and lowering the shoulders in order to relax the trapezoidal muscles and push the chin backwards ("double chin position"). Once in this position, carry out an auto elongation, a body anteposition, and move the elbows outwards and towards the arms longitudinal axis with an active contraction of the serratus anterior muscle. Maintaining these parameters, take a lower costal inspiration in order to elevate the ribs, then a maximum expiration, and finally hold your breath (expiratory apnea) with a closed glottis and emphasizing the aforementioned parameters. This position should be maintained during 25s, breathing eventually if necessary, but always keeping in mind that for each exercise the apnea posture should be maintained during a total of 25 seconds.

Exercise 2: same starting position and execution. The only difference is the elevation of the arms above the head by flexing the shoulders, and keeping the remainder of parameters.

Exercise 3: identical to exercise 1, but on your knees.

Exercise 4: on four legs, hands on the ground and perpendicular to the shoulders, wrist in dorsal flexion and fingers extended, slightly separated and pointing inwards. Knees bent at a 90 degrees angle, feet in dorsal flexion and toes touching the ground.

In this position, bring the shoulders forward over the hands, with the elbows pointing outwards and flexing the head. The remainder of parameters and execution is the same as in the preceding exercises.

Exercise 5: in a genupectoral position, but in this case we will only work on the dorsal concavity side. For this, we will place the concave side arm along the body, with the elbow bent at 90 degrees and the hand in front of the head; while the other arm is extended along the body. In this position, carry out the same execution as in the previous exercises, but in this case pushing forwards only with the concave side elbow.

Evaluation of results and monitoring

We can compare the results of the previous measurements with the results of 3 months of these exercises application (table 2). It can also be observed a variable interest in home sessions exercises on the part of the subjects, so that while subjects 1 and 2 practiced more than 6 sessions a week on average, for subject 3 the number of sessions/week was slightly above 4.

Discussion/implications for the clinical practice

Idiopathic scoliosis is a structural scoliosis whose typical characteristics are: apparition during growth with fast accentuation during puberty, mostly on women, and with no demonstrable cause, being found out of every pathology context. Even though its origin remains unknown, it’s been discussed a whole range of aetiological factors (genetic linked to sex, neurological, muscular. . .).

On the other hand, HG is defined as a postural technique that causes a decrease in the thoracic diaphragm tonic activity, and as a result of this and its concomitant pressure associated decrease, both intra-thoracic and intra-abdominal, is achieved, among others physiological effects, an activation of different muscular groups which are antagonists, from a postural point of view, of the thoracic diaphragm. Based on this definition and the results obtained in a previous study in which we showed it causes modifications of cervical and dorsolumbar static in healthy subjects,
we have decided to investigate its application in different spine pathologies, such as idiopathic scoliosis.

Table 2 Results of the measurements performed before-after (3 months) of this exercise program application.

<table>
<thead>
<tr>
<th></th>
<th>Patient 1 Before</th>
<th>After</th>
<th>Patient 2 Before</th>
<th>After</th>
<th>Patient 3 Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cobb angle</td>
<td>40º</td>
<td>36º</td>
<td>36º</td>
<td>36º</td>
<td>28º</td>
<td>39º</td>
</tr>
<tr>
<td>Perdriolle torsiomter</td>
<td>5º in D10</td>
<td>5º in D10</td>
<td>5º in D12</td>
<td>10º in D12</td>
<td>5º in D8</td>
<td>5º in D8</td>
</tr>
<tr>
<td>Nash/Moe Scale</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Gibbosity</td>
<td>10º</td>
<td>7º</td>
<td>11º</td>
<td>11º</td>
<td>7º</td>
<td>4º</td>
</tr>
<tr>
<td>Rachis lateral deviation between C7 and S1*</td>
<td>+ 0.3cm</td>
<td>+ 0.2cm</td>
<td>+ 0.2cm</td>
<td>+ 0.5cm</td>
<td>+ 1.8cm</td>
<td>+ 1.4cm</td>
</tr>
</tbody>
</table>

*C7 is deviated to the right in relation to S1

In regards to the results interpretation, we must point out that the patients have not practiced the exercises program with the same frequency; what could in part explain the results obtained: patients 1 and 2, who have shown a greater adherence to the treatment, have managed, in global terms, to control the curves evolution, so that a stabilization or even an improvement have been observed (patient 1) in the main results variable, that is to say, in the rachis lateral deviation measured through the Coob angle; as well as in other variables, with a tendency to the vertebrae rotation stabilization, in base to both radiological parameters (Nash and Moe scale) and gibbosity morphological measurements associated to the same measure via a scoliometer. However, patient 3, in spite of not showing progression in some of the measured parameters, has increased her curve by 11 degrees Coob, although we think this also could be related to the girl’s age. In regards to the clinical practice these results could mean that the regular execution of a HG exercise program in girls with minor to moderate idiopathic scoliosis (up to 50 degrees Coob) in the evolutionary phase, could help to prevent their evolution. We believe the substantiation to the encouraging results obtained, especially in the results main variable for patients that have practiced the exercises program regularly, could be determined because idiopathic scoliosis is part of the called "posture deficiency syndrome" (DPS); so in this context, an inappropriate postural control response in this type of scoliosis could lead to muscular tension at antigravitational and parietal muscles level. In this sense, we have observed that a diaphragmatic hypertony causes a modification of the body dynamic and postural balance, which is logical if we bear in mind that the thoracic diaphragm is one of the main muscles responsible for the posture, and plays a fundamental role in the body dynamic balance, and thus we think that a significant proportion of dorsal scoliosis are mainly due to a postural tonic activity unbalance between the upper thoracic diaphragm, and that therefore their reeducation would imply a tonic harmonization of the thoracic diaphragm (as well as the rest of the skeletal muscular groups
involved); such as the one obtained through the regular practice of a HG program. We also think interesting to mention that patient 3 presents gibbosity stabilization, despite the Coob angle increment, data which allows us to corroborate that the external morphology can be corrected even in the case of an aggravation of said angle, and also to hypothesize that this ribs orientation normalization could probably improve the respiratory function of the subject. Our hypothesis, derived from a prior study’s results, would be based on that in idiopathic scoliosis with dorsal curves there is a thoracic diaphragm involvement to its tonic aspect level that depends on the central posture management and that the application of normalization techniques of the thoracic diaphragm, such as HG, should have a positive effect on the thoracic and vertebrae deformities evolution of this type of scoliosis. The future purpose of this study will be to develop a new therapeutic tool for the prevention and stabilization of scoliosis of idiopathic origin.

Conflict of interests

The authors of the present article "Preliminary study on the action of hypopressive gymnastics in the treatment of idiopathic scoliosis”, certify that:
All financial and material sources for the execution of this study are explicitly declared in the manuscript.
All financial relationships established by any of the authors with any organization that could have a conflict of interests regarding some aspects of the present study, are explicitly reflected in the manuscript.

Bibliography

25.