Malaysian Journal of Medical Research. Volume 7(2) 14-21
https://doi.org/10.31674/mjmr.2023.v07i02.002

MJMR
Malaysian Journal of Medical Research

Malaysian Journal of Medical Research

Online ISSN: 2550-1607

www.mjmr.com.my

Original Article

The Effect of Halo Gravity Traction Application on Trunk Visual Perception in Severe And Rigid Kyphoscoliosis Patients

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Abstract

Introduction: Severe and rigid kyphoscoliosis creates serious cardiopulmonary and neurological problems in patients. Self-ego and body perception deteriorate due to scoliosis. Our aim in the study was to evaluate the effect of halo gravity traction application on trunk visual perception as well as provide solutions to the basic problems that may occur in kyphoscoliosis. **Methods:** Eleven patients diagnosed with advanced and rigid kyphoscoliosis with a mean age of 20.5 years who underwent halo gravity traction between 2019 and 2020 were included in our study. The trunk visual perception scale was used to evaluate the perception of patients about trunk deformities before and after traction. Cobb angle values were examined. **Results:** The mean coronal Cobb angle before traction was 95.9 ° ± 8.3 °, after the traction, it was 88.4 ° ± 6.6 °, the mean pre-traction sagittal cobb angle was 85.2 ° ± 8.2 °, and after the traction, it was 79.2 ° ± 7.6 °. Statistically, these changes were significant (p <0.05). In the anterior body perception evaluation, the mean score before the procedure was 1.294 ± 0.469 and after the procedure, it was 1.764 ± 0.5622. The posterior body perception was 1.117 ± 0.3321 and after the procedure, it was 2.176 ± 0.6359. The changes in body perception assessment from the front and the back were statistically significant (p <0.05). **Conclusion:** Halo gravity traction can have a positive effect on the perception they have about trunk deformities, together with providing solutions to the basic problems of patients with rigid and advanced kyphoscoliosis. In addition, it has a positive effect on radiological deformity.

Keywords: *Halo Gravity Traction; The Trunk Appearance Perception Scale; Kyphoscoliosis*

Introduction

The surgical management of severe and rigid kyphoscoliosis is difficult. Cardiopulmonary and neurological complications can significantly increase morbidity and mortality. Especially in such patients, pulmonary dysfunction before surgery increases the risk of mortality in the intraoperative period (Asher *et al.*, 2003). In order to solve these problems, halo gravity traction (HGT) is applied. At the same time, HGT provides a partial correction of severe curvatures (Bago *et al.*, 2010).

In rigid kyphoscoliosis, the sharp curvature disrupts the body image perception of the patients. One of the biggest concerns of patients is a cosmetic deformity. Self-esteem and self-confidence are negatively affected in patients. Therefore, it is necessary to know how patients perceive their trunk

Received: 8th February 2023; Revised version received on: 15th February 2023; Accepted: 1st April 2023

deformity. The perception of an impaired body appearance by the patient negatively reflects on the health-related quality of life (HRQL) assessment (Bogunovic., *et al* 2013).

The truncal appearance perception scale (TAPS) is a tool that can be used to evaluate the truncal deformity perceived by the patient. It is evaluated by expressing how the patient perceives the body in three different views (Bouchoucha *et al.,* 2011).

In our study, the effect of HGT application performed before surgery in patients with rigid and severe kyphoscoliosis on body perception was evaluated. In addition radiological changes were evaluated.

Methodology

Patients with advanced and rigid kyphoscoliosis receiving preoperative HGT traction between January 2019 and December 2021 at a secondary health care institute were included in the study. It was planned in patients with rigid and severe kyphoscoliosis who had undergone preoperative halo gravity traction. Ethics committee approval was taken from the same hospital. Our study was conducted in accordance with the Helsinki Declaration. Consent forms were signed by all patients before the procedure. The patients were evaluated by the Truncal Appearance Perception Scale and scoliosis radiography before the traction procedure and in the first month after the traction procedure.

Patient inclusion criteria for HGT application

1. Severe and rigid kyphoscoliosis with flexibility less than 30° and a coronal cobb angle above 80 ° (Greiner, 2002).
2. Sagittal cobb angle above 70 ° (Han *et al.,* 2020).
3. No progressive neurological deficit.
4. Severe impairment of respiratory function tests with forced vital capacity percentage (FVC%) ≤50% (Johnston *et al.*, 2011).

Patient exclusion criteria for HGT application

1. The presence of a bone disease

HGT application procedure

Since the procedure was performed under sedation, patients fasted for four hours before the procedure. Midazolam 0.02 mg/kg and fentanyl 1mcg/kg were administered intravenously for sedation in the operating room. After sterilizing the places to be screwed with 10% povidone-iodine solution, 2% lidocaine was applied with 1 ml of local anesthesia. Two screws were placed 3 cm proximal to the corrugator supercilii muscle on the anterior mid-pupillary line, and the other two screws were placed bilaterally in the lateral mastoid location at the rear. Screw locations are shown in Figure 1.

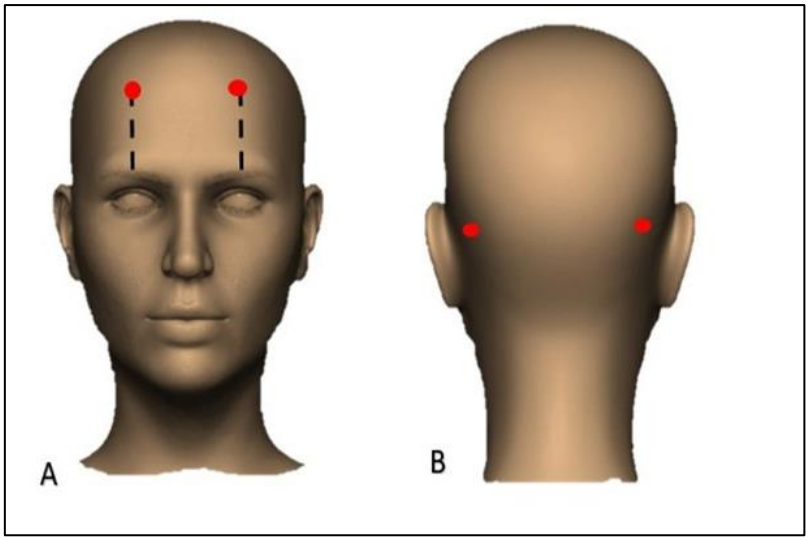

Figure 1: Halo screw insertion places. A: Anterior screw locations, B: Posterior screw locations

After the procedure, a brain tomography was taken in each patient to see the screw-bone relationship. Patients rested for one day after the procedure. The initial weight was 5 kg, and it was increased by 1-2 kg according to the daily patient tolerance. The target weight was chosen between 30-50% of normal weight. Daily neurological examination and pain conditions were examined. Screws were tightened every two days to prevent loosening. Daily screw skin insertion sites were treated with 10% povidone-iodine solution. Since the duration of the patients' stay in traction was between 12 and 16 hours, the device was adjusted so that they could remain in the mobile, sitting position, and traction in the bed. Traction was applied to the patients in addition to the bathroom, toilet, and sleep. Total traction time was on average 30-35 days.

Trunk Appearance Perception Scale

TAPS is a scale based on self-evaluation of the patient's body from three different points of view. Scoring is made according to the perception of the body from the front, back, and forward bending (Adam's test) shapes. The greatest curvature is given 1 point, the smallest curvature is given 5 points. Low scoring means that the perception of curvature is worse (Bouchoucha *et al.*, 2011). Body visual perception scale is given in Figure 2.

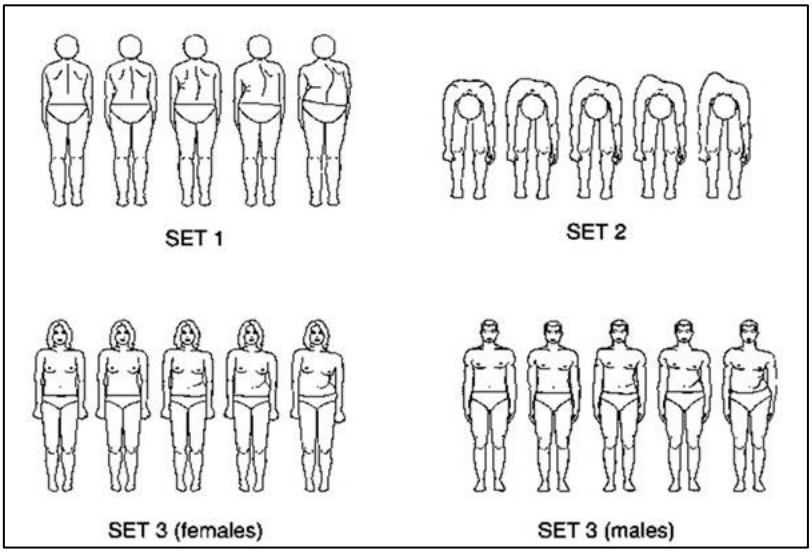

Figure 2: Trunk Appearance Perception Scale

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Radiological Evaluation

Scoliosis and lateral bending radiographs were taken before and after HGT. All screenings were taken standing. The patients were screened with locked knees, feet shoulder-width apart, elbows bent and hands closed bilaterally in the supraclavicular fossa. Coronal and sagittal cobb angles, the sagittal vertical axis (SVA), and the coronal balance were measured using the surgimap (Nemaris Inc, New York, United States) program on a computer. The measurements of a patient calculated using Surgimap are given in Figure 3.

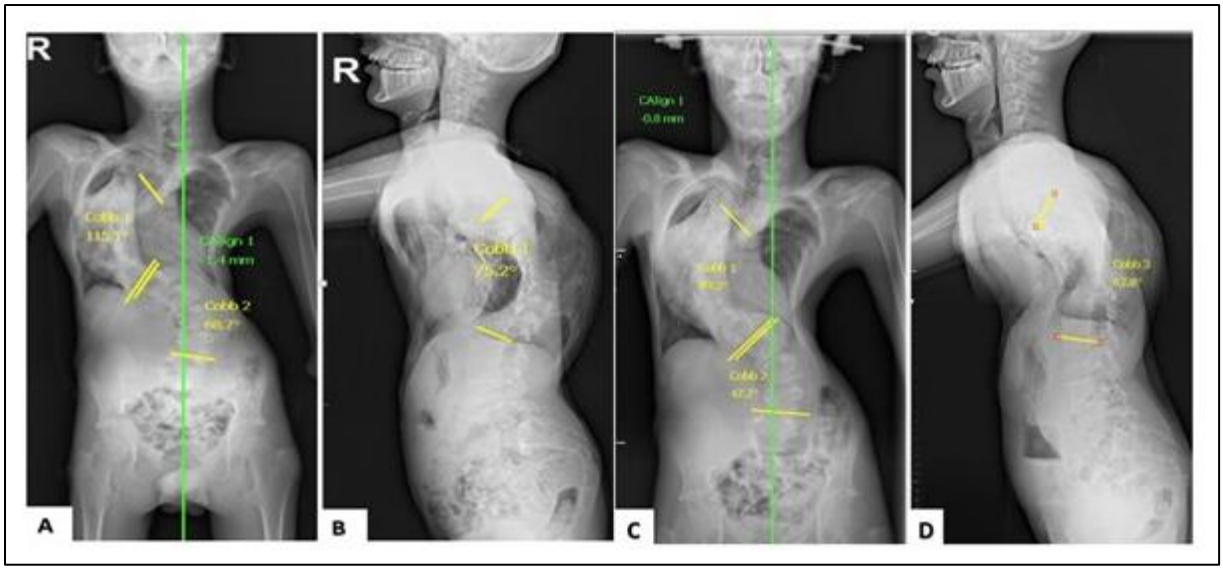

Figure 3: Surgimap measurements of the scoliosis x-rays. A: Coronal x-ray before traction, B: Sagittal x-ray before traction, C: Coronal x-ray after traction

Statistical Analysis

The values of the Truncal Appearance Perception Scale and radiological measurements before the HGT application and in the first month after the HGT application are in Table 1.

Table 1: Values before and after the traction process

Parameters	Minimum	Maximum	Mean	Std. Deviation
Pre HGT Coronal Cobb Angle	81.7	107.8	95.976	8.3243
Pre HGT Sagittal Cobb Angle	75.6	106.8	85.206	8.2186
Pre HGT Coronal Balance	1.1	3.5	2.153	0.6453
Pre HGT Sagittal Vertical Axis	1.1	4.0	2.465	0.6955
Post HGT Coronal Cobb Angle	76.5	98.3	88.412	6.6817
Post HGT Sagittal Cobb Angle	56.1	90.2	79.241	7.6876
Post HGT Coronal Balance	0.8	22.0	3.082	4.9114
Post HGT Sagittal Vertical Axis	0.8	4.1	2.288	0.7524
Pre HGT front view	1.0	2.0	1.294	0.469
Pre HGT back view	1.0	2.0	1.117	0.3321
Pre HGT Adam's view	1.0	2.0	1.352	0.4925
Post HGT front view	1.0	3.0	1.764	0.5622
Post HGT back view	1.0	3.0	2.176	0.6359
Post HGT Adam's view	1.0	2.0	1.529	0.5144

The Wilcoxon Signed Ranks Test was used for analysis. Statistical analysis was performed by an independent statistician who was blind to surgical procedures. The statistical significance level was set at $p < 0.05$.

Results

A total of 11 patients were included in the study. The average age was 20.5 and 5 of the patients (45.5%) were male and 6 (54.5%) were female. The mean initial height was 153.3 ± 17.8 cm, and the mean height after the procedure was 155.1 ± 18.6 cm. This change was statistically significant ($p < 0.05$). The average weight before the procedure was 47.8 ± 13.2 kg, and the average weight after the procedure was 48.1 ± 13.3 kg. Statistically, this change was not significant. The demographic characteristics of the patients are summarized in Table 2.

Table 2: Demographic Features of the Patients

n:11	Minimum	Maximum	Mean	Std.Deviation
Age	8	29	20.5	6.5
Pre HGT Height (cm)	112	178	153.3	17.8
Post HGT Height (cm)	115	182	155.1	18.6
Pre HGT Wight (kg)	21	70	47.8	13.2
Post HGT Weight (kg)	22	72	48.1	13.3

Radiological Results

In the evaluation of radiological parameters, the mean coronal Cobb angle before the procedure was 95.9 ° ± 8.3 ° and after the procedure was 88.4 ° ± 6.6 °. The mean sagittal Cobb angle before the procedure was 85.2 ° ± 8.2 °, and after the procedure was 79.2 ° ± 7.6 °. The mean coronal balance before the procedure was 2.1 ± 0.6 cm, and it became 3.0 ± 4.9 cm after the procedure. Before the procedure, the mean SVA was 2.4 ± 0.6 cm and it became 2.2 ± 0.7 cm after the procedure. Statistically, changes in coronal cobb and sagittal cobb angles were significant ($p < 0.05$). The radiological data are summarized in Table 1.

Trunk Appearance perception scale results

In the assessment of anterior visual body perception, one of the TAPS sub-parameters, the mean score before the procedure was 1.294 ± 0.469 and the mean score after the procedure was 1.764 ± 0.5622. The mean posterior body perception before the procedure was 1.117 ± 0.3321 and the mean score after the procedure was 2.176 ± 0.6359. The mean bending forward (Adam's) body perception assessment before the procedure was 1.352 ± 0.4925 and the mean score after the procedure was 1.529 ± 0.5144. The changes in body perception assessment from the front and the back were statistically significant ($p < 0.05$). There was no statistically significant change in visual body perception between sexes. TAPS data were summarized in Table 1.

There was no statistically significant difference in the changes of traction application on the Trunk Appearance Perception according to gender. Statistical results are given in Table 3.

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Table 3: The Results of the Statistical Analysis

Parameters	**Pre-Post HGT**		**Pre-Post HGT According to Sex**	
n:11	**Z**	**Asymp. Sig. (2-tailed)**	**Z**	**Asymp. Sig. (2-tailed)**
Coronal Cobb Angle	-3.504[b]	0.000	-1.214	0.225
Sagittal Cobb Angle	-3.575[b]	0.000	-2.533	0.011
Coronal Balance	-0.200[b]	0.841	-2.918	0.004
Sagittal Vertical Axis	-1.071[b]	0.284	-0.107	0.915
Front view	-2.828[b]	0.005	-0.365	0.715
Back view	-3.448[b]	0.001	-0.537	0.591
Adam's	-1.732[b]	0.083	-0.159	0.873

Discussion

The surgery for rigid and severe kyphoscoliosis is a complicated problem. It may be associated with serious complications including spinal cord injury and associated plegia (Koller *et al.*, 2012). It can also significantly impair preoperative pulmonary functions in patients (O'Brien *et al.*, 1994). Halo gravity traction is applied to patients with rigid kyphoscoliosis to reduce the risks of both pulmonary problems and neurological complications in the intraoperative period (Li *et al.*, 2017 and Liang *et al.*, 2010).

In rigid kyphoscoliosis, halo traction, which can provide a solution to these two basic problems, can also contribute to the radiological correction of rigid curves (McIntosh, Ramo & Johnston, 2019 and Mehrpour *et al.*, 2017). Bogunovic *et al*. reported that preoperative halo-gravity traction had a corrective effect on deformity in patients with severe kyphoscoliosis (Murray, 2007). Mehrpour *et al* also reported that HGT application has a corrective effect on both the main coronal Cobb angle and the kyphosis Cobb angle in rigid kyphoscoliosis and that this method decreases the neurological complications that may occur in surgeries (Nemani *et al.*, 2015) . Li *et al*. reported that HGT application improved coronal and sagittal cobb angles and alsı improved pulmonary functions (Theologis *et al.*, 1993). Our study has similarities with the literature. The coronal Cobb angle before HGT was 95.9 ° ± 8.3 ° on average, and 88.4 ° ± 6.6 ° after the procedure. The mean sagittal cobb angle before the procedure was 85.2 ° ± 8.2 °, and 79.2 ° ± 7.6 ° after the procedure. The aim of this study was to see the effect of this radiological improvement obtained with HGT on the trunk deformity perception of the patient.

Although radiological improvements are important in evaluating the treatment in scoliosis patients, it is also related to how the patient perceives her own body image. Tests evaluating the perception of the deformity by the patient in scoliosis patients are available in the literature. Theologis *et al*. evaluated the severity of the trunk deformity using the cosmetic spinal score by taking anteroposterior photographs of scoliosis patients (Wang *et al.*, 2021). Zaina *et al*. developed the Trunk Aesthetic Clinical Evaluation Test (TRACE). This test is based on the evaluation of shoulder drop, scapulae condition, hemithorax, and waist asymmetry from the patient's photographs (Yu *et al.*, 2020). Bago *et al*. Developed the TAPS test that enables the deformity to be evaluated according to three different points of view of the body. In our study, we used the body appearance perception assessment test defined by Bago *et al* to evaluate the visual perception of the trunk. This test can be useful in evaluation (Zaina *et al.*, 2009). In our study, the most important change perceived in deformity after HGT was in the perception of the posterior aspect of the trunk. We think this result was related to radiological healing. A more significant improvement in the coronal Cobb angle resulted in a positive result in the evaluation on perception as well. At the same time, we think that the improvement in the coronal Cobb angle is the most important factor affecting the change in the lengthening of the person. The least changed body appearance perception assessment was based on the perception of the trunk in forward-bending. This may be due

to the inability of HGT application to affect this rotational deformity due to the sharp and rigid rib deformities in the apex. Thoracoplasty is needed to correct these types of rib deformities.

There are several limitations of our study. The perception of the patient's own trunk deformity can be positively or negatively affected by the relatives of the patient. It is not possible to eliminate this interaction. Weight and face shape affect the patient's approach to her own self This also affects the Trunk Appearance Perception Test. The small sample size is also a limitation of our study.

Conclusion

HGT application is a safe and effective way to solve problems in patients with severe and rigid kyphoscoliosis. It safely provides a gradual radiological improvement in sagittal and coronal Cobb angles. HGT application, which can provide solutions to problems and facilitates the surgeon during surgery, also has positively affects the perception of truncal appearance. It increases the self-confidence of the patients. HGT application is an effective method that can positively affect deformity problems and body perception in severe and rigid kyphoscoliotic patients.

Conflicts of Interest

The authors declare that they have no conflict of interests.

Acknowledgment

We would like to thank the director of the hospital, neurology, acute medicine, medical department, and the head of the emergency department for their continuous support in improving emergency services related to Neurologic Emergencies

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