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EFFECTIVENESS OF HALO TRACTION IN THE TREATMENT OF PATIENTS WITH SEVERE RIGID SCOLIOSIS

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ABSTRACT

Objective: Halo traction reduces surgical risks in the treatment of severe rigid scoliosis. The aim of this study was to demonstrate the effectiveness of halo traction in the treatment of these patients.

Materials and Methods: Patients with severe rigid scoliosis who underwent halo traction before surgery were retrospectively evaluated. The halo traction gradually increased, and a total weight of 50% of the body weight was applied. The major coronal curvature (Cobb angle), thoracic kyphosis (TK) and length between T1 and L5 in the coronal plane were evaluated before halo traction, at 3 weeks under traction, and before surgery.

Results: Five patients (mean age: 12.8 years) were evaluated. Before halo traction, the mean major Cobb angle was 112°, TK was 78.6°, and the length between T1 and L5 was 261 mm. The average traction duration was 43 days. It was determined that there was a statistically significant improvement in the major Cobb angle, TK, and the length between T1 and L5 between the patients' baseline and 3rd week and presurgery measurements. It was observed that 85% of the total Cobb angle and TK were completely corrected, and 84% of the length between T1 and L5 was obtained after 3 weeks of halo traction.

Conclusion: Approximately 85% of the correction is achieved after the first three weeks of halo traction application. There was no significant improvement after this period. Thus, halo traction for 3 weeks may be considered sufficient.

Keywords: Halo traction, scoliosis, thoracic kyphosis.

INTRODUCTION

The management of severe, rigid scoliosis in children presents significant challenges because surgical correction carries a significant risk of neurological injury[1,2]. This can be caused by direct trauma to the spinal cord or indirectly by overstretching or compromising its vascular supply. It is essential to ensure that such catastrophic complications are avoided, as these injuries can lead to permanent dysfunction and long-term disability. Therefore, careful pre-operative planning and adjunctive treatments are essential to minimise these risks while achieving the desired spinal correction[3].

Traditional techniques, including posterior spinal fusion, anterior release or osteotomies may be insufficient or carry high risks in patients with severe curvature and reduced flexibility[4]. To minimise this risk, surgeons have used various methods to achieve a partial correction in the size of the major curve prior to definitive surgery, including halo-femoral, halo-pelvic and halo-gravity traction (HGT). Traction methods such as halo-tibial and halo-femoral provide serious corrections but require long-term bed rest. Halo gravity traction allows mobilization and patient compliance is better[5, 6].

Halo traction, a method initially developed for cervical spine injuries, has since been adapted for scoliosis management, particularly in cases of severe and rigid deformities[7]. By applying controlled, continuous longitudinal traction to the spine, halo traction facilitates gradual correction over time, allowing for increased curve flexibility, reduction in rib prominence, and better overall balance of the spine. This pre-operative treatment modality can enhance the safety and effectiveness of subsequent definitive surgical intervention, often improving outcomes in a patient population at high risk for complications[8,9].

The aim of our study is to investigate whether pre-operative halo traction in rigid curves corrects coronal and sagittal balance and for how long it should be used.

MATERIALS AND METHODS

Five patients with severe rigid scoliosis who applied to the scoliosis outpatient clinic in Department of Orthopedics and

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Traumatology, İstanbul University, İstanbul Faculty of Medicine, and underwent halo traction application were evaluated retrospectively. The ethics committee was approved the study protocol (approval number: 2024/1892, date: 15/11/2024) in line with the principles of the Declaration of Helsinki. Patient consent form was added protocol. Halo traction was applied according to the previously described protocol[10]. Halo traction was applied to the patients under general anesthesia in the operating room. Four to six halo pins were placed and tightened to 6-to 8-inch pounds depending on the patient's size and skull bone density. Usually, the pins were checked for looseness and tightened every 24-48 hours. Traction was started after checking that the pins were in the safe zone with cranial computed tomography scan. Two kilograms was applied on the first day. In the following days, the weight was increased by 2 kilograms every day until it reached half of the body weight (Figure 1).

Neurologic checks were performed 8.00 am, 04.00 pm, 00.00 am. Daily cranial nerve and upper/lower extremity neurologic examinations were performed. The patient underwent posterior fusion in the operating room and the halo traction was removed. Before starting traction, at the 3rd week of traction application and before fusion surgery, long cassette antero-posterior and lateral radiographs were taken. In radiological evaluations, major coronal curvature degree, thoracic kyphosis (TK) curvature degree (T4-12) and T1-L5 length were evaluated.

In the measurements, the degree of coronal curvature and TK was determined by the Cobb method, and the T1-L5 length was determined according to the length of the line drawn from the midpoint of both corpuses on the antero-posterior radiograph (Figure 2-4). Halo traction was applied to the patients for 6 weeks. Halo-traction related complications were noted in each case.

Figure 1. Application of halo traction for severe scoliosis

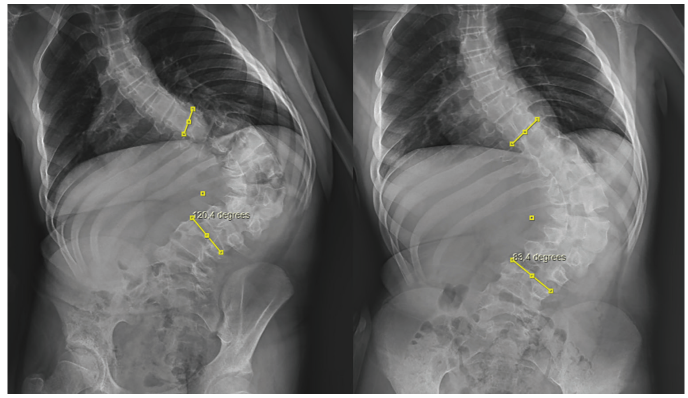

Figure 2. Thirteen year old male patient, change in Cobb angle at 3rd week follow-up (from 120 to 83 degrees)

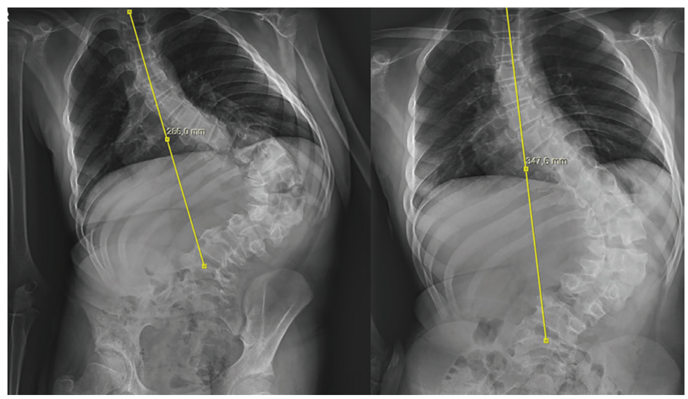

Figure 3. Thirteen year-old male patient, lengthening between T1-L5 at 3rd week follow-up (from 286 to 347.6 mm)

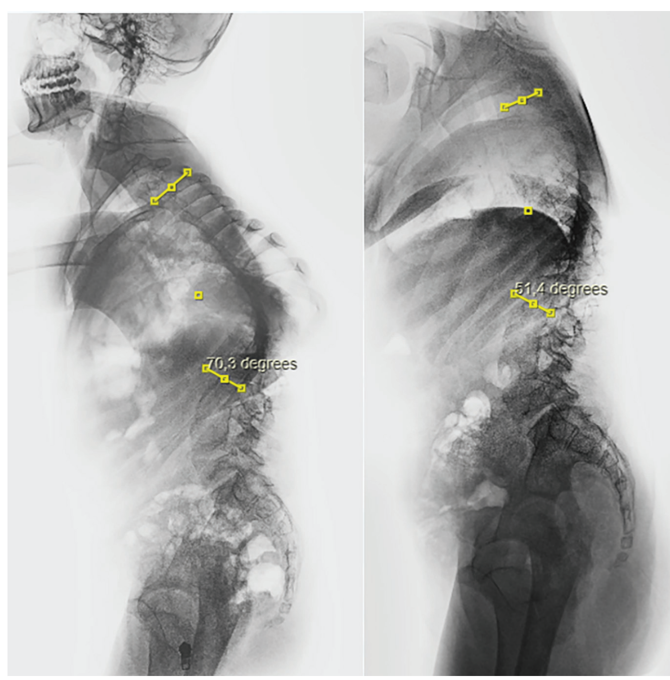

Figure 4. Correction of thoracic kyphosis at 3rd week follw-up (from 70 to 51 degrees)

Statistical Analysis

SPSS v.27 software (MacOs, IBM Corp., Armonk, NY,USA) was performed for analysis. Shapiro Wilk test was used for analysis the distribution of variables. The nonparametric tests were performed due to skewed distribution. Descriptive statistics were presented as mean (standard deviation), minimum, and maximum values. Friedman test was used to present the difference between the baseline, 3rd week after treatment, and before surgery values for within-group analysis. When a significant difference was found in the within-group analysis, Wilcoxon's signed ranks test was used to analyze pairwise comparisons. Confidence interval was 95% and p-value <0.05 was considered significant.

RESULTS

A total of five pediatric patients (3 female, 2 male) with rigid severe scoliosis, with a mean age of 12.8 years, were retrospectively evaluated. Pre-halo traction measurements showed an average major coronal curve of 112 (92-140) degrees, an average TK of 78.6 (24-108) degrees, and a mean spinal length between T1 and L5 of 261 (234-294) mm (Table 1). Halo traction was applied for an average duration of 43 days, during which traction force was gradually increased to reach 50% of each patient's body weight.

In the radiological evaluation at the end of the 3rd week, major coronal curve angle reduced to 86.4 (64-105) degrees, TK reduced to 52.4 (17-75) degrees and mean spinal length between T1-L5 in the coronal plane increased to 315.4 (285-346) mm. However, in the evaluation of the patients at the and of the traction treatment (before surgery) mean major coronal curve was 82 (72-103) degrees, TK was similar to the 3rd week of halo traction treatment and mean spinal length between T1-L5 in the coronal plane was 326.2 (298-358) mm (Table 1).

In the evaluation at the end of the halo traction treatment, it was seen that 85% of the correction in the Cobb angle in the coronal plane, all of the TK correction, and 84% of the length between T1-L5 were obtained after 3 weeks of traction (Figure 5).

Only one patient experienced a pin tract infection, which was effectively treated with oral antibiotics. No neurological complications were reported during or after the traction period.

DISCUSSION

The results of this study support the role of halo traction as an effective preoperative adjunctive therapy in the treatment of pediatric patients with severe, rigid scoliosis. Surgical correction of such deformities is often associated with risks, including neurological injury and significant complications due to the rigidity and severity of the curves. As demonstrated in this retrospective analysis, halo traction provides significant benefits in terms of curve flexibility and reduction, thereby reducing these risks and facilitating safer and more effective surgical procedures.

Previous studies have demonstrated that HGT is an effective adjunct in the treatment of severe spinal deformities in pediatric patients. Reported correction rates for the major curves following HGT range from 12% to 35% in the coronal plane and 17% to 35% in the sagittal plane[11]. In our study, we observed a coronal curve correction rate of 26.7% and a sagittal curve correction rate of 33.3%, aligning with these previous findings. These results further support the role of HGT in achieving significant curve correction in pediatric patients with severe and rigid spinal deformities.

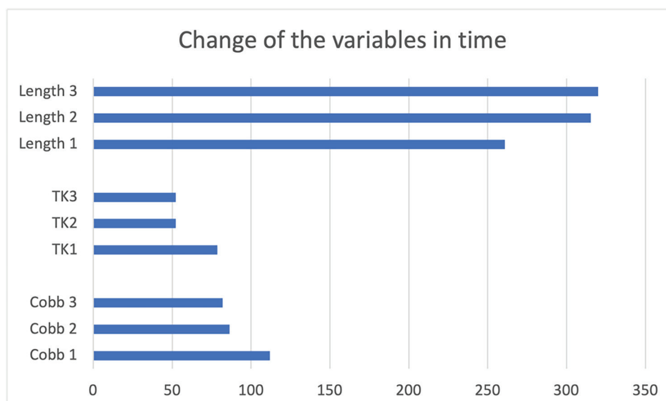

Figure 5. Change of the variables in time
1: Baseline, 2: After 3 weeks of halo traction, 3: Presurgery, TK: Thoracic kyphosis

Table 1. Within-group assessment of the variables at 3 different times

	Baseline	After 3rd week	Pre-surgery	p[a]	p[b]
Cobb angle mean (SD)	112.0 (20.4)	86.4 (17.6)	82.0 (17.1)	0.016*	3rd w-baseline: 0.043** Presurg-baseline: 0.043** Presurg-3rd w: 0.197
TK mean (SD)	78.6 (32.4)	52.4 (22.3)	52.4 (22.2)	0.015*	3rd w-baseline: 0.043** Presurg-baseline: 0.043** Presurg-3rd w: 1,000
Length mean (SD)	261.0 (26.1)	315.4 (26.3)	326.0 (26.1)	0.007*	3rd w-baseline: 0.043** Presurg-baseline: 0.043** Presurg-3rd w: 0.043**

*p[a]<0.05 is significant for within-group analysis (Friedman test), **p[b]<0.05 is significant for pairwise comparisons of the variables (Wilcoxon test).
TK: Thoracic kyphosis, SD: Standard deviation, 3rd w: After 3rd week of halo traction application, Presurg: Presurgery

In the current literature, there is still no consensus on the optimum duration of traction. Watanabe et al.[9] reported that 84.7% of major curve correction occurred within 3 weeks, while Park et al.[12] observed 96% of correction within 4 weeks. In a study conducted by Hwang et al.[13] on 59 patients, they found a 28.2% improvement in Cobb's angle in the first week, 34% in the second week, 33.8% in the third week and 32.2% in the fourth week with pre-operative halo traction. They also argued that the effectiveness of halo traction decreased after the third week. In a study conducted by Koptan et al.[14], they argued that halo traction is a safe method and that maximum correction can be achieved with continuous traction and that the complication rate is minimal for tractions up to 50% of body weight and that 2 weeks of traction is sufficient.

In a study conducted by Wang et al.[15] with 62 patients with a Cobb angle over 120 degrees, it was revealed that the complication rate decreased with halo traction in a 2-year follow-up and that it could reduce the Cobb angle by up to 50% in 4-6 weeks of use. In a study conducted by Rocos et al.[16] with 42 patients and an average of 42 days of halo use, 72 mm of extension was detected in the first 3 weeks and they argued that halo traction should be used for at least 4 weeks. Yamin et al.[17] argued that the spinal cord is sensitive to traction in severe rigid curves and that pre-operative halo traction application is effective in preventing neurological complications, and they recommended anterior release and halo traction in the first stage and posterior instrumentation in the second stage in curves with a Cobb angle of over 80 degrees and less than 20% flexibility. Park et al.[12] argued that halo traction should not be applied for more than 3 weeks. Otherwise, it was stated that complications such as osteopenia, infection and loosening of pin roots would occur. Sponseller et al.[8] argued that osteotomy and complication rates were lower when halo traction was applied.

The findings highlight that after an average of 43 days of halo traction, there was a marked improvement in the major coronal curve, TK, and spinal length. However, 85% of the total Cobb angle correction and 84% of the increase in spinal length between T1 and L5 were achieved within the first three weeks of traction. The rapid and substantial correction within this period suggests that further prolongation of halo traction beyond three weeks may not yield significant additional benefits. This supports the conclusion that three weeks is the optimal duration for halo traction, balancing efficacy with patient comfort and safety.

Moreover, the absence of neurological complications in this study aligns with existing literature that advocates for the safety of halo traction when applied with gradual increments of force, reaching up to 50% of the patient's body weight. The only complication reported-a pin tract infection-was managed effectively with oral antibiotics, reinforcing the relatively low morbidity associated with the procedure when performed under appropriate clinical protocols. This study underscores the utility of halo traction in reducing surgical complexity by pre-operatively decreasing the severity of the spinal deformity. By improving both coronal and sagittal plane alignment, halo traction enhances the overall flexibility of the spine, potentially reducing the extent of surgical dissection and instrumentation required for definitive correction. These improvements in spinal alignment contribute to more favorable postoperative outcomes and a lower likelihood of complications.

Considering the limitations of the study, the small number of patients included in the study seems to be a potential limitation. In addition, the patient population included different diagnoses and the heterogenity of the curve pattern and flexibility of curve was another limitation. Furthermore, there is no comparison with a control group to assess the efficacy of preoperative HGT.

CONCLUSION

In conclusion, halo traction is a valuable tool in terms of both coronal and sagittal plane deformities and also trunk length in the management of pediatric patients with severe, rigid scoliosis. The significant correction achieved within the first three weeks of traction suggests that this is an optimal timeframe for its use prior to surgical intervention. Future studies with larger cohorts and longer follow-up periods are recommended to further validate these findings and refine protocols for the application of halo traction in this patient population.

Ethics

Ethics Committee Approval: The study was approved by the İstanbul University of Local Ethics Committee (approval number: 2024/1892, date: 15/11/2024).

Informed Consent: Retrospective study.

Footnotes

Financial Disclosure: The author declared that this study received no financial support.

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