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Case Study

Application of extracorporeal shockwaves in the treatment of scoliosis: a case report

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Abstract. [Purpose] In a pilot investigation, extracorporeal shockwave therapy was applied to patients with idiopathic scoliosis. This case report aimed to describe the effects of repeated extracorporeal shockwave therapy on the clinical signs of a patient with scoliosis due to a functional tethered cord syndrome. [Subject and Methods] In June 2016, a 13-year-old girl presented with a left thoracic curvature. Radiograph showed a left thoracic curve of 24°. An angle of trunk rotation of 21° was measured using a scoliometer. Extracorporeal shockwave therapy was proposed to support conservative treatment. Five sessions of extracorporeal shockwave therapy were applied. Finger-floor distance and the angle of trunk rotation before and after each application of extracorporeal shockwave therapy were measured. [Results] The average finger-floor distances before and after extracorporeal shockwave therapy were 22.6 cm and 15.6 cm, respectively. The average angles of trunk rotation before and after the therapy were 13° and 10.2°, respectively. [Conclusion] The short-term effect of extracorporeal shockwave therapy was revealed in this study. The neural structures that inhibited free mobility of the spine were mobilized. Furthermore, deformity was reduced by applying extracorporeal shockwave therapy.

Key words: Scoliosis, ECSWT, Tethered cord

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INTRODUCTION

Scoliosis is a structural three-dimensional deformity of the spine and trunk. It often exhibits a certain amount of spinal torsion and a disturbance of the sagittal profile coupled to the lateral deformation[1, 2)]. Scoliosis may be an expression or a symptom of certain diseases (e.g., neuromuscular, congenital, due to certain syndromes or tumors), but the majority of patients with scoliosis (80–90%) are 'idiopathic' because the underlying cause is not apparent[2, 3)]. In patients with severe adolescent idiopathic scoliosis (AIS) compared with normal subjects, the thoracic vertebral column is significantly longer without detectable change in spinal cord length evaluated as cord-to-vertebral length ratios[4, 5)]. The initiation and progression of AIS are speculated to result from vertebral column overgrowth through a lordoscoliotic maladaptation of the spine to the subclinical tether of a relatively short spinal cord[4, 5)]. A subclinical tether of the spinal cord does not lead to any neurologic symptoms related to the spinal cord[4–6)].

The hypothesis of asynchronous neuro-osseous growth proposes that a relatively short cord can lead to hypokyphosis in the thoracic area and hence curve initiation with or without progression of the scoliosis[4, 5)].

Deng et al.[6)] have found signs of functional tethering of the spinal cord in their MRI studies. They have described that in patients with idiopathic scoliosis (1) the spinal canal is shorter than the vertebral column, (2) the spinal cord is deformed at the apical level of the curve and that (3) the spinal cord is deviated to the concave side leaving a lateral cord space (LCS) on the convex side.

Tomaschewski found that functional impairment of forward flexion (IFF) is the precursor of structural spinal deformity. Among the 686 healthy school children aged 9 and 10 years, 16.5% had IFF in at least one motion segment. Of these children,

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Fig. 1. Standardized measurement of the finger-floor distance (a) and finger-wall distance (b)
Taken from Santos[12], with kind permission by Pflaum, Munich.

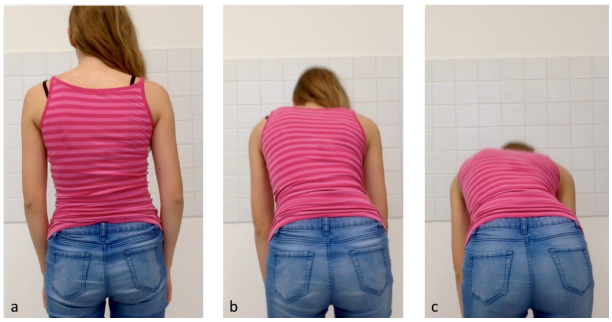


Fig. 2. Demonstration of the dynamic change of the deformity during the forward bending test
The deformity is hardly visible in upright position (a), but it becomes more prominent when the patient bends forward (b and c).

27% developed AIS within 1 year follow-up after the first screening[7]. These findings support the theory of functional tethering. However, IFF is highly prevalent and considered as being physiological in younger age groups[8]. Following the rationale of Tomaschewski[7], external manipulation may influence IFF, the 'flatback' contracture found in the lower thoracic area in patients with beginning AIS, and have a beneficial effect on the 3D deformity of the spine and trunk. In a pilot investigation[9], chiropractic intervention was replaced by extracorporeal shockwave therapy (ECSWT). The beneficial effects of ECSWT on deformity were revealed, and patients reported subjective feelings of relaxed back after the application. The application of this therapy was documented in a video[10]. ECSWT is currently applied to treat idiopathic scoliosis with stiff curvatures and pain due to high-corrective braces[11]. The mobility of the spinal cord is closely correlated to the finger-floor distance (FFD) or the finger-wall distance (Fig. 1)[12, 13].

Recently, a patient presented with atypical idiopathic scoliosis. She had a rare sign of functional tethering of the spinal cord; only a slight deformity was visible in the upright position, but the deformity (lateral deviation and angle of trunk rotation) was more prominent when bending forward (Fig. 2). In idiopathic scoliosis, there is typically no clear dynamic increase in lateral deformity in the forward bent position, known as the Adam's forward bending test. This finding is classified as a possible sign of a functional tethered cord syndrome in the absence of any pain. The objective of this case report is to describe the effects of repeated ECSWT on the clinical signs of deformity.

CASE REPORT

In June 2016, a 13-year-old girl presented with a left thoracic curvature. X-ray showed a left thoracic curve with a Cobb angle of 24° 3 weeks prior to treatment. An initial angle of trunk rotation of 21° was measured with a scoliometer. During the clinical investigation, in upright standing position, a slight deformity was observed; in the forward bending test (lateral deformity) and trunk rotation seemed to increase drastically (Fig. 2). Such dynamic changes in deformity are usually not found in patients with idiopathic scoliosis; thus, the scoliosis of the patient was classified as being due to a functional tethered cord syndrome. The patient had no neurologic signs or symptoms. She had no pain, but reported that the deformity appeared after she fell off a horse one year before her presentation to the clinic. A high-corrective brace was prescribed, but the patient was not fully compliant. Therefore, to support the treatment, extracorporeal shock wave therapy (ECSWT) was proposed (Fig. 3). No other treatment than part time brace treatment and ECSWT were applied.

Extracorporeal shock wave therapy frequently is used for the treatment of myofascial pain syndromes. With this apparatus high amplitude pulses of mechanical energy generated by an electromagnetic coil are applied[9].

Five sessions of ECSWT were applied between November 10 and December 8, 2016. The FFD before and after each ECSWT application was measured. FFD measurement was performed with both feet close together and knees fully extended (Fig. 1). The angle of trunk rotation (ATR) was determined using a Scoliometer™. ATR was measured following a standard procedure during the Adam's forward bending test, with both knees extended and any leg length difference balanced. The Storz Medical Masterpuls® MP 100 radial shockwave system with a trigger point applicator was used (Fig. 4). The patient provided a written informed consent to publish her data, clinical pictures, and radiographs.

Repeated measurements of FFD without intervention were performed twice directly prior to and directly after each the ECSWT intervention. A high variability was found, which was dependent on the motivation of the patient (2–3 cm). When the patient was motivated by the therapist she was able to decrease the FFD a bit further than without motivation.

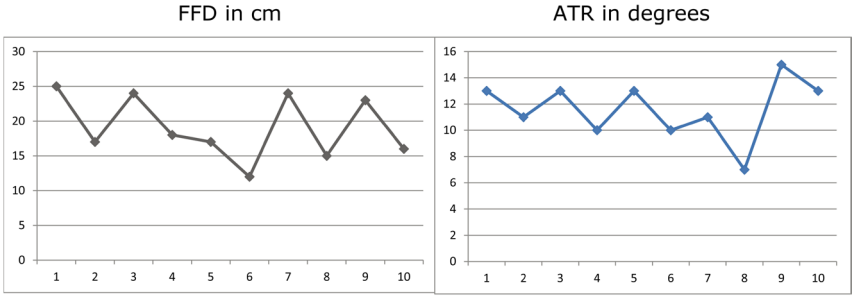
Fig. 3. ECSWT was performed in a standardized position[10)]

Fig. 4. The Storz Medical Masterpuls® MP 100 radial shock-wave system with a trigger point applicator was used in this study

Fig. 5. FFD and ATR values measured before and after each shock wave intervention (SW)

Values measured before and after each of the 5 interventions

	1st. SW		2nd. SW		3rd. SW		4th. SW		5th. SW	
	before	*after*	*before*	*after*	*before*	*after*	*before*	*after*	*before*	*after*
FFD	25	17	24	18	17	12	24	15	23	16
ATR Th.	13	11	13	10	13	10	11	7	15	13



The graph shows the FFD (left) and ATR values (right) before and after each of the five interventions. The odd and even numbers on the graphs indicate the values obtained before and after the ECSWT application, respectively.

RESULTS

The results of the interventions are outlined in Fig. 5. The average FFDs before and after ECSWT application were 22.6 cm and 15.6 cm, respectively ($p<0.01$). The average ATRs before and after the therapy were 13° and 10.2°, respectively ($p<0.05$). Figure 5 shows that both FFD and ATR values decreased after the intervention, but returned to their initial values after 3 to 5 days. For the ATR, the technical error is estimated to be 1°[14)]. Therefore, FFD and ATR decreased more than the expected technical error by the ECSWT application.

DISCUSSION

The concept of functional tethering of the spinal cord is conclusive in patients with idiopathic scoliosis. Deng et al.[6)] determined the signs of functional tethering of the spinal cord in their MRI studies. While identification of the true cause

of idiopathic scoliosis is interesting, these new findings should also encourage us to seek for alternative treatments for this condition. ECSWT application was introduced in 2013 to treat idiopathic scoliosis[8]. This treatment aims to mobilize the neural structures in the spinal canal.

Herein, the patient is not classified as being idiopathic, as evidenced by clear functional signs of a tethered cord. However, this patient may also serve as a model for the treatment of idiopathic scoliosis. Idiopathic scoliosis does not behave like this special case, but recent MRI findings have demonstrated that a functional tethering of the spinal cord is clearly evident in patients with idiopathic scoliosis. The ATR of 21° measured at the first presentation reduced prior to study commencement. Whether this improvement was completely or partially due to brace treatment is unknown. However, as stated before she was not fully compliant and did not wear the brace for a minimum of 20 hrs each day as prescribed initially.

Interestingly, ECSWT application reduced the tether and deformity. Consequently, ECSWT is assumed to be an alternative treatment for patients with idiopathic scoliosis and those with clinical signs of a functional tethering (like stiff curvatures, pain provoked in the slump test in different regions of the spine[12], certain pain syndromes during the first application of high-corrective brace).

The reason why FFD and ATR returned to their initial values days after the application is unclear. Nevertheless, the patients all felt significantly more relaxed, and the pain due to high-corrective brace was completely eliminated by only one intervention. Further investigations are necessary to elaborate the true value of ECSWT application. A combination of a few sessions of ECSWT and application of an exercise program to mobilize the nervous system, particularly the spinal cord, should be tested clinically.

In conclusion, this study revealed the short-term effect of ECSWT on deformity. The neural structures that inhibited free mobility of the spine were mobilized. Furthermore, deformity was reduced by ECSWT application. Further investigations that focus on how to achieve long-term effects of ECSWT application are necessary.

Conflict of interest

The author declares that there is no conflict of interest with regard to the content of this paper.

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