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ORIGINAL CLINICAL ARTICLE

No effect of osteopathic treatment on trunk morphology and spine flexibility in young women with adolescent idiopathic scoliosis

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Abstract

Introduction Brace treatment is the gold standard for patients with mild adolescent idiopathic scoliosis (Cobb angle 20°–40°). However, negative psychosocial impacts, physical constraints and incompliance cause many patients and parents to seek for so-called holistic and apparently less harmful approaches within the field of complementary and alternative medicine (CAM). Osteopathy—manual interventions on the viscera and locomotor system—is widely used for scoliosis. There is, however, a complete lack of evidence regarding its efficacy. We, therefore, tested the hypothesis that osteopathy alters trunk morphology, a prerequisite to unload the concave side of the scoliosis, and that it halts curve progression.

Methods This was a prospective, controlled trial of 20 post-pubertal young women (20°–40° idiopathic scoliosis) randomly allocated to an observation (group 0) or osteopathic treatment (group 1). The latter comprised three sessions (5 weeks). Trunk morphology (clinical examination, video rasterstereography) and spine flexibility (MediMouse®) were assessed at a pre- and post-intervention with a 3-month interval (blinded examiner). We chose scoliometer measurement (rib hump, lumbar prominence) as the main outcome parameter.

Results Two patients in the treatment group refused further treatment and the final examination, as they felt no benefit after two osteopathic treatments. Regression analysis for repeat measurements (independent statistician) revealed no therapeutic effect on rib hump, lumbar prominence, plumb line, sagittal profile and global spinal flexibility.

Conclusions We found no evidence to support osteopathy in the treatment of mild adolescent idiopathic scoliosis. Therefore, we caution against abandoning the conventional standard of care for mild idiopathic scoliosis. As for other CAM therapies, the use of osteopathy as a treatment option for scoliosis still needs to be clearly defined.

Keywords Osteopathy · Adolescent idiopathic scoliosis · Trunk morphology · Randomised trial

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Introduction

The treatment of mild idiopathic scoliotic curves (Cobb angle 20°–40°) during growth to halt progression is a classic conservative orthopaedic domain [1]. However, bracing as the cornerstone of this strategy remains controversial, as its effect is limited by non-compliance and potential negative psychosocial effects [2–9]. Intensive scoliosis-specific rehabilitation regimens might alter the curve's natural history, but these programmes are time-consuming and lack evidence regarding their effectiveness [10–12]. Therefore, patients will often abandon these traditional approaches in favour of so-called "holistic" approaches, which are allegedly less harmful and more efficient alternatives. As in other fields of medicine, complementary and alternative medicine (CAM) methods are increasingly promoted and utilised. Amongst these, osteopathy has gained widespread popularity, in particular for spinal disorders [13]. The term "osteopathy" was coined by Andrew Taylor Still, MD in the second half of the nineteenth century. Education, licensing and practice rights vary from country to country. The philosophy of osteopathy emphasises the musculoskeletal system as the origin of health or disease and promotes the "integration" of body, mind and spirit. However, there are no strict definitions of this apparently comprehensive and drug-free approach. It is based on the belief that a range of *manual* treatment interventions on the viscera and the locomotor system will stimulate self-regulatory mechanisms, ultimately restoring form and function, for example, in scoliotic spines. To date, there is no scientific evidence supporting these assumptions [14]. Legal, medical, ethical and economic implications and the increasing use of this approach in children and adolescents which we have observed in our spinal practice have prompted us to perform a prospective randomised trial.

The hypothesis of this study was "osteopathic treatment improves trunk morphology and spine flexibility in post-pubertal young women with mild idiopathic scoliosis."

Methods

Patient selection

After approval of the local Ethical Committee (Ethikkommission beider Basel, Switzerland),[1] informed parental written consent and patient's written assent was obtained from all participants. Twenty consecutive young women with adolescent idiopathic scoliosis were recruited from the spine clinic by the principal investigator (CH) according to the following inclusion criteria:

- Idiopathic adolescent scoliosis
- Cobb angle 20°–40°
- No restrictions regarding curve type
- Standing PA spine radiograph within 3 months before the start of the study
- At least 2 years post-menarchal status to exclude growth and ongoing brace treatment as confounding factors
- Upper age limit: 20 years
- No concomitant scoliosis therapy (e.g. physiotherapy, brace treatment etc.) and no vigorous sporting activities within 3 months before the start and during the study

Randomisation

Blocked randomisation (allocation ratio 1:1) of eligible patients was performed with a concealed envelope. It either contained a request to avoid any kind of therapy during the observation period (0, control group) or to contact the osteopath (CS or AE) within 3 days (1, intervention group).

Pre- and post-intervention assessment

All patients underwent two standardised assessments of their trunk morphology and spine flexibility at a 3-month interval (measurement I, prior to randomization and II, 3 to 4 weeks after the last osteopathic intervention) between 5 and 7 pm by a blinded, experienced scoliosis physiotherapist (CN).

Clinical examination included body weight, standing height, body mass index, plumb line from C7 and pelvic obliquity. Trunk rotation—rib hump and lumbar prominence—was assessed with a Bunnell scoliometer™ (Orthopedic Systems, Inc., Hayward, CA, USA) in a standing, bent-over position (arms dangling, palms pressed together) with the pelvis horizontalised (wooden blocks) and the subject standing on a foot template [15]. The scoliometer measurement is a reliable non-invasive method when used by a single trained observer, with the best reproducibility in a standing, forward-bending position [16, 17]. The intrarater agreement is excellent (intraclass correlation coefficient Rho = 0.995 and Rho = 0.998 for the thoracic and lumbar regions, respectively) and the accuracy was 2° [15, 17–19]. There is a statistically significant correlation between scoliometer values and the radiographic Cobb angles for each of the segments measured (Pearson's correlation coefficient $r = 0.685$, 0.572 and 0.677 for thoracic, thoracolumbar and lumbar curves, respectively) [20]. Therefore, the scoliometer provides a fairly reliable estimation of the Cobb angle at the initial clinical examination of a scoliosis patient. However, if the initial Cobb angle is known and its relationship to the gibbosity calculated, longitudinal measures of the gibbosity over time provide the clinician with a highly reliable estimation of the Cobb angle and this is, therefore, a reliable tool to detect curve progression or improvement,

[1] http://www.ekbb.ch.

especially if further radiographs within a short time interval are not feasible [21].

Trunk morphology was also assessed without radiation using a static video rasterstereographic surface analysis (Formetric®, DIERS International, Schlangenbad, Germany) tool. When using this apparatus, the patient is standing upright, the feet are placed in a foot template and the shoulders are in 10° of abduction. Stereography is a reproducible and reliable method for the three-dimensional surface measurement of idiopathic scoliosis with Cobb angles of up to 50° [22–24]. Rotational standing surface values are smaller than actual vertebral rotation angles but correlate well ($r = 0.79$). Adam's forward-bending test combined with scoliometer measurements correlate badly with the standing stereographic examinations. As there is an *individual correlation* between stereographic and clinical measurements of rib hump/lumbar prominence with frontal plane Cobb angle, a given assessment of one patient may be related to a wide range of possible Cobb angles. These methods are, therefore, often restricted to use as screening tools, but are suitable for longitudinal observations and evaluation of patients without direct reference to radiographs, as in this study [23, 25–29]. Significant Cobb angle changes would alter at least one associated topographic measurement [30].

Active global sagittal and coronal spine *flexibility* was objectively assessed with computerized non-invasive scanning (SpinalMouse®, Idiag, Fehraltorf, Switzerland) of the trunk in maximal flexion, extension and bilateral side-bending. The device was found to be applicable for in vivo studies of the sagittal profile and range of motion, as consistently reliable results were found for the flexibility measurements of global regions, e.g. the thoracic spine, but not for individual segmental flexibility [31–33].

Osteopathic intervention

The protocol comprised three standardised osteopathic sessions (90-, 30- and 60-min duration), with the 90-min session at the start and the others at 1 and 4 weeks interval, respectively. They included patient education on osteopathic principles, history taking, diagnostic osteopathic testing and osteopathic visceral and parietal manipulations by two experienced, certified osteopaths (CS, AE). Parietal interventions act directly on the locomotor system (muscles, joints, ligaments, tendons) and, thereby, influence the function of the inner organs, whereas, vice versa, visceral osteopathic treatment works on the inner organs, which, by their connective tissues, interact with the locomotor system.

The osteopaths defined the protocol according to their daily common osteopathic practice for scoliosis patients. None of the patients had undergone osteopathic treatments previously.

Statistical analysis

The analyses were performed by an independent statistician (TE) who was blinded to the group assignments. Sample size calculation was based on the variable of primary interest (rib hump measurements) using the nQuery Advisor 4.0 software package (Statistical Solutions Ltd., Boston, MA, USA). Based on pilot data, a sample size of 10 patients per group had an 80% power to detect a difference in means of 2° between the rib hump measurements, assuming a common standard deviation of 1.5° using a two-group t-test with a 0.05 two-sided significance level.

Demographic and procedural data were analysed for normal distribution by the Shapiro–Wilk test, and the data are reported as mean (standard deviation [SD]) or median (interquartile range). Repeated measures were analysed with regression techniques using the PROC MIXED procedures in SAS software version 9.1 (SAS institute, Cary, NC, USA). The regression model used the patient's group assignment (G), the repeated measures factor (I, indicated the two measurements) and the interaction between the two (G*I) as independent variables ($Y = b0 + b1(G) + b2(I) + b3(G*I)$). Here, the interaction parameter b3 is of interest, because a statistically significant non-zero value for b3 indicates that the two patient groups reacted differently to the interventions.

Results

The demographic characteristics of the patients did not show significant differences (Table 1). Two patients missed an osteopathic session. They wanted to be excluded from the study since they felt that they did not benefit from the intervention. No intervention-related side-effects or complications were recorded.

The statistically non-significant interaction term of the regression analysis for all parameters indicated that the change between the measurements levels was not different between the two groups (Table 2).

The hypothesis that osteopathy alters trunk morphology in scoliotic post-pubertal girls was, therefore, rejected.

Because of the non-compliance of two patients in the osteopathy group, the planned sample size was missed in the treatment group. Based on the actual sample size and measurements, the study has a power of 80% to detect a difference of 3.1° of the rib hump between the study groups.

Table 1 Patients and curve characteristics

	Osteopathy (group 1)	Control (group 0)
Age (years)	16.5 [15.2–18.5]	14.7 [12.3–18.1]
Years post-menarche	3.6 [2–7]	2.8 [2–4.5]
Height (cm)	165.0 [152.4–175.1]	161.1 [147.5–175.0]
Weight (kg)	54.1 [45.3–65.3]	51.8 [44.6–58.5]
Body mass index (kg/m^2)		
Measurement I	19.9 [17.2–22.8]	19.76 [17.3–22.3]
Measurement II	20.0 [17.8–23.0]	20.58 [17.2–23.5]
Main curve Cobb angle (°)	27.1 [20–40]	31.5 [22–40]
Thoracic curve	5	4
Lumbar curve	0	2
Thoracolumbar curve	4	2
Double curve	1	2

Data are presented as mean [range]

Discussion

The primary goal of treating mild idiopathic scoliotic curves (20°–40°) is curve stabilisation by breaking the vicious cycle of concave overload: growth inhibition–vertebral deformation–scoliosis progression and, subsequently, more asymmetric load on the vertebral growth plates. The logical concept is, therefore, diminution of these forces and breaking of the vicious circle. The current literature shows that only continuous wear of a well-fitted brace will be biomechanically effective [5, 9, 34, 35]. At least 50% in-brace Cobb angle correction and adherence to a 20–23 h per day wear regimen are mandatory for success [36–39]. However, the use of bracing is controversial: compliance (hours in brace/prescribed brace regimen) has been found to be as low as 62–67.5% in rigid braces [6, 40, 41] and pooled data in meta-analysis on observation, exercises and bracing did not provide evidence to recommend one approach over the other [42, 43]. This may reflect the physical and psychosocial impacts of a rigid, visible and warm orthosis. There may also be a conflict between an otherwise healthy patient and a disease, which, to the patient, represents only a radiographic phantom but otherwise does not cause pain or cardiopulmonary symptoms or major cosmetic upset in the early stages.

Therefore, patients with adolescent idiopathic scoliosis are particularly liable to consulting non-MD practitioners who offer gentle, brace-free therapeutic pathways within the wide and popular field of CAM. It is prudent not only to inquire as to a patient's use of CAM therapy, but also to consider the medico-legal and economic implications, as the patient usually remains the responsibility of the MD, most commonly an orthopaedic surgeon. The risk of possible adverse reactions is small, since most CAM is safe, but the main issue is clinical efficacy and the raising of false expectations. Our own current systematic research using scientific databases (Medline, Embase, Cinahl, Cochrane Library, Index to Chiropractic Literature, PEDro) and a former extensive literature survey conducted by the Scoliosis Research Society [44] including over 30 complementary and alternative approaches for the treatment of scoliosis such as acupuncture, biofeedback, chiropractic, craniosacral therapy, Feldenkrais, Rolfing and Reiki—to name the most prominent—could not reveal any scientific rationale to support their use. In particular, there is a complete lack of serious, high evidence level studies on manual therapies such as osteopathic, chiropractic and massage technique [14]. Nevertheless, their popularity continues to increase. The Internet offers access to more than 1.5 million sites on scoliosis, 130,000 on scoliosis and alternative medicine, and 60,000 on the osteopathic treatment of scoliosis, most of them of limited quality and poorly informative [45]. However, it is only human nature that some parents and patients judge this information by how well it agrees with "the way they want the world to be" [46]. It is our duty to learn about existing and emerging CAM options in our field of speciality and to educate and counsel our patients accordingly.

The major concerns are exposing the patient to the natural history of the disease by delaying or—even worse—abandoning the conventional standard of care and to burden the health care system with additional costs in favour of unproven strategies. Moreover, with alternative health care professionals entering the mainstream of health care and an increasing number involved in scoliosis care, parents and patients seek their physician's opinion about the risks and benefits of CAM or may ask for referral to or a prescription for CAM .

We aimed at exemplarily validating the effectiveness of one of the most popular CAM representatives, osteopathy. It is premised on the understanding of humans as units of body, mind and spirit, balanced by self-regulatory mechanisms and the interdependency of structure and function. Different craniosacral, myofascial and visceral manual techniques diagnose and relieve imbalances and restrictions in the interconnections between the motion of all organs and structures of the body. In contrast to bracing, this is effectuated smoothly and away from scrutiny by peers, neighbours or relatives. As scoliosis is defined by an inherent asymmetry which disturbs functionality and structures on all levels, it is a logical target disease for osteopathic treatment. The commonly accepted orthopaedic rationale relies on the ability to improve the three-dimensional morphology of the scoliotic trunk as a prerequisite to halt or slow down curve progression. Consequently, all parameters describing trunk morphology are feasible endpoints to assess the effects of any scoliosis

Table 2 Results of clinical examination, video stereography and flexibility assessment

	Measurements*		Within group test (MI vs. MII)		Change (MI vs. MII) between the groups	
	MI	MII	*t* value	*P* value	*F* value	*P* value
Clinical examination						
Plumb line C7 (mm)						
Osteopathy	5.6 ± 11.2	6.9 ± 17.3	0.52	0.60	0.09	0.77
Control	6.2 ± 14.0	8.4 ± 13.8	1.02	0.32		
Rib hump (°)						
Osteopathy	6.4 ± 4.6	6.3 ± 5.3	0.15	0.88	0.63	0.44
Control	9.7 ± 4.1	8.7 ± 4.9	1.36	0.19		
Lumbar prominence (°)						
Osteopathy	2.0 ± 8.3	2.9 ± 8.7	0.93	0.36	0.59	0.45
Control	5.8 ± 4.1	5.7 ± 3.9	0.12	0.9		
Video stereography						
Trunk length (cm)						
Osteopathy	43.1 ± 2.8	43.6 ± 2.6	1.55	0.14	1.09	0.31
Control	40.4 ± 4.3	40.4 ± 4.5	0.16	0.87		
Plumb line C7 (mm)						
Osteopathy	13.0 ± 6.3	14.0 ± 4.7	0.5	0.62	2.57	0.12
Control	16.2 ± 5.7	12.9 ± 8.1	1.84	0.08		
Pelvic balance (mm)						
Osteopathy	9.1 ± 12.7	7.6 ± 10.4	1.79	0.09	2.29	0.15
Control	5.8 ± 3.8	6.0 ± 4.1	0.27	0.79		
Pelvic torsion (°)						
Osteopathy	−2.9 ± 10.7	−1.7 ± 9.9	2.69	0.02	4.70	0.046
Control	−0.3 ± 3.1	−0.4 ± 3.0	0.24	0.81		
Trunk rotation (°)						
Osteopathy	−5.3 ± 14.5	−5.6 ± 14.1	0.36	0.73	0.01	0.90
Control	−10.1 ± 11.0	−10.3 ± 9.7	0.23	0.83		
Sagittal balance (mm)						
Osteopathy	21.4 ± 22.1	23.2 ± 25.6	0.30	0.77	0.17	0.68
Control	18.0 ± 23.6	23.3 ± 22.4	0.95	0.355		
Thoracic kyphosis (°)						
Osteopathy	49.9 ± 5.2	47.6 ± 7.0	1.81	0.9	3.02	0.102
Control	44.3 ± 7.9	45.5 ± 11.3	0.59	0.56		
Lumbar lordosis (°)						
Osteopathy	41.4 ± 5.5	40.1 ± 5.8	0.70	0.49	0.01	0.91
Control	42.4 ± 5.8	40.9 ± 7.9	0.94	0.36		
Flexibility (°)						
Sagittal flexion T1–11						
Osteopathy	13.4 ± 11.7	8.0 ± 13.4	1.11	0.28	3.03	0.10
Control	10.2 ± 10.3	15.9 ± 8.7	1.39	0.18		
Sagittal flexion T11–L2						
Osteopathy	22.1 ± 9.0	20.6 ± 9.7	1.07	0.30	0.41	0.52
Control	20.9 ± 5.5	18.1 ± 5.2	2.28	0.037		
Sagittal flexion L2–S1						
Osteopathy	45.1 ± 5.7	45.7 ± 9.4	0.27	0.79	0.15	0.70
Control	43.7 ± 9.6	43.2 ± 10.1	0.28	0.78		

Table 2 continued

	Measurements*		Within group test (MI vs. MII)		Change (MI vs. MII) between the groups	
	MI	MII	*t* value	*P* value	*F* value	*P* value
Side bending T1–11 L						
Osteopathy	29.0 ± 6.8	31.3 ± 6.0	0.53	0.60	0.14	0.71
Control	20.1 ± 9.2	20.3 ± 13.3	0.06	0.95		
Side bending T1–11 R						
Osteopathy	14.3 ± 12.0	23.7 ± 8.0	2.07	0.056	2.47	0.13
Control	12.3 ± 3.5	12.4 ± 9.0	0.03	0.98		
Side bending T11–L2 L						
Osteopathy	9.9 ± 3.5	13.4 ± 5.4	1.38	0.18	1.76	0.20
Control	13.0 ± 4.2	12.1 ± 4.4	0.42	0.68		
Side bending T11–L2 R						
Osteopathy	14.3 ± 3.5	13.3 ± 3.3	0.64	0.53	1.88	0.19
Control	10.9 ± 5.4	12.7 ± 5.7	1.37	0.19		
Side bending L2–S1 L						
Osteopathy	25.3 ± 7.0	25.6 ± 3.3	0.11	0.91	0.77	0.39
Control	18.5 ± 6.4	21.8 ± 8.2	1.49	0.15		
Side bending L2–S1 R						
Osteopathy	25.4 ± 6.8	25.0 ± 3.9	0.14	0.89	0.00	0.99
Control	20.3 ± 8.4	19.9 ± 8.6	0.16	0.87		

treatments, including instrumented fusions. Though the gold standard to determine curve progression is Cobb angle measurement, ethical concerns would be raised in regard to repeat exposure to ionising radiation within a relatively short study observation period [47]. Non-invasive three-dimensional analysis of trunk topography with a surface scanner is a reliable alternative [48]. The best documented and most reliable clinical examination is scoliometer measurement of trunk rotation, which was used for our pre-study power analysis and determination of group sizes.

Randomisation, blinding of observers and statisticians, as well as isolating osteopathy as the only parameter with potential influence on trunk morphology during the observation period are *strengths* of this study. Ongoing growth and concomitant treatment as potential confounding factors were removed by selecting post-pubertal young women, which is an advantage over former studies on manual treatments [49]. Randomised controlled studies during the pubertal growth spurt including control groups, brace groups and osteopathy groups would reach the highest evidence level, but would not match ethical standards, as the patients in two groups would be deprived from the common standard of care.

Two relatively small groups of 10 patients each and two drop-outs in the intervention group are identifiable *weaknesses* of this study. However, the only existing studies on the manipulative treatment of young patients with scoliosis are case reports with one, two and three patients [50–52] and a pilot study on chiropractic treatment which described six patients [49]. They all combine manipulative cycles with concomitant, simultaneous other treatments, such as electric stimulation, bracing or exercise programmes. Also, these studies lack control groups and evaluate outcomes only by visual assessments or palpation. These weak points render the objective evaluation of the therapeutic effects of spinal manipulation on scoliosis impossible.

The lack of any osteopathic treatment effect in our study might be ascribed to a dose–effect problem, but the frequency and details of the three sessions over a 5-week period were proposed by experienced and certified osteopaths and coincides with that of a former case series [50]. In contrast, a pilot study on chiropractic manipulation based on a survey among American chiropractors relied on a six-month protocol [49].

Our study does not exclude that osteopathy could improve scoliotic trunks if applied earlier in the disease process. However, this is unlikely, as accelerated spinal growth during the pubertal growth spurt represents the main driving force for curve progression and adds many more therapeutic challenges compared to the post-pubertal setting, as is described here.

In conclusion, CAM sees a widespread global application in the treatment of adolescent idiopathic scoliosis in clinical practice and increasingly gains legitimacy and loyal followers, despite the lack of efficacy data from rigorous clinical trials. No evidence of effectiveness was shown in this trial, which emphasises the need to further investigate osteopathy and similar methods. Given the well-established biomechanical understanding of increased concave loading and subsequent growth inhibition in progressively scoliotic growing spines, it is scientifically implausible that a range of smooth manual treatments may break this vicious cycle. The proposed effectiveness of other underlying mechanisms as suggested by CAM—yet enigmatic—remain to be proven. Meanwhile, this approach continues to constitute a belief system rather than science, a complement but not an alternative to the current standard of scoliosis care and should, consequently, not replace current established orthopaedic strategies [5, 9, 34, 35]. The reimbursement of CAM for scoliosis treatment at a time when public health system budgets are overstretched should be a matter for urgent debate.

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