PRM+ (2019) Volume 2 Issue 1 6–10
ISSN 2489-8457

Correcting functional scoliosis

Jussi Timgren, MD[1]

Abstract
Objective
The study aimed to observe the effects of three known types of functional scoliosis caused by pelvic asymmetry on the spatial relationship of the upper cervical vertebrae. The study additionally assessed the use of a lesser known muscle energy technique for the alignment of atlas and axis subsequent to pelvic alignment.
Methods
A retrospective study of 104 patients (36 men, age: 13 to 86 years) with musculoskeletal complaints was undertaken. A Palpation Meter® was used to compare iliac crests and inferior scapular angles. The first and second cervical vertebrae were manually assessed. Patients performed self-correcting muscle-energy maneuvers for pelvic obliquity and for atlas and axis alignment.
Results
Reversible pelvic obliquity was found in 100 patients (96.2%). Iliac asymmetry was associated with anteriorly rotated ilium (53%) with apparent leg lengthening. Ilium upslip causing apparent leg shortening was identified in 47% of patients. A consistent pattern between the three distinct forms of functional scoliosis and the positioning of the two upper cervical vertebrae emerged.
Conclusions
Pelvic asymmetry affected the positioning of the upper cervical vertebrae. Reversible pelvic obliquity is a common but overlooked condition causing functional scoliosis and leg length differences that patients can be instructed to align themselves.

Keywords:
sacroiliac joint; functional scoliosis; pelvis; pelvic tilt; malalignment; atlas; axis

INTRODUCTION

Functional scoliosis resulting from pelvic obliquity has received little attention within medical literature. Commonly viewed as a manifestation of leg length difference (LLD), functional scoliosis in relation to long-standing LLD has been associated with degenerative changes of the lumbar spine, altered gait mechanics, and low back pain. When LLD is minor, the use of shoe lifts has been advised; however, more substantial LLD (>20 mm) has been recognized to require consideration of operative intervention.

A study by Raczkowski et al. on 369 children with LLD revealed elimination of scoliosis by use of a shoe lift intervention leading to leg length equalization. However, our previous study indicated that functional scoliosis and LLD share a common and reversible origin in pelvic obliquity. In a PRM practice, 97% of the first visit patients presented with functional scoliosis caused by pelvic obliquity. Three manifestations of pelvic obliquity were presented: anterior rotation, upslip of the ilium, and sacral torsion that is noticeable after alignment of iliac bones. With each, the compensatory curves inevitably appear in all three segments of the spine. For all the conditions, the patient was instructed to perform a self-correcting muscle energy maneuver, which resulted in restoration of symmetry in all cases. Due to common asymmetry reoccurrence, patients were instructed to continue the exercises at home. The possibility of using self-correcting maneuvers for pelvic alignment has been previously described Schamberger and Don Tigny, among others. Considering to the recurrent nature of the condition, it is vital that the patient learns to manage the asymmetries independently, in order to avoid repeated visits to manual therapists for alignment.

The study aimed to observe the manifestations of the three known types of functional scoliosis caused by pelvic asymmetry and their effects on the spatial relationship of the upper cervical vertebrae and to evaluate the results of establishing spinal symmetry using patients' own muscle strength.

METHODS

A retrospective study was undertaken including patients who visited a private doctor's office (a specialist in Physiatry) for the first time in 2018 due to diverse complaints of pain or discomfort. The patients' medical records were retrieved for the analysis. As no additional examinations or interventions related explicitly to the study were performed, approval from an ethical board was not required. The assessment of two possible pelvic

[1] Self-employed part-time private practitioner (retired), Järvenpää, Finland
Conflicts of interest: None to declare
Corresponding author: Jussi Timgren, Laurilantie 89, FI-04480 Haarajoki, Finland. Tel. +358 50 596 8960. Email jussi.timgren@pp.fimnet.fi

Figure 1. Anterior rotation of left ilium causes elevation of a left iliac crest, apparent lengthening of the left leg, C-scoliosis with thoracic convexity to the right and elevation of the right scapulae. A lift under the right foot evens the iliac crests and straightens out the scoliosis, at least partially.

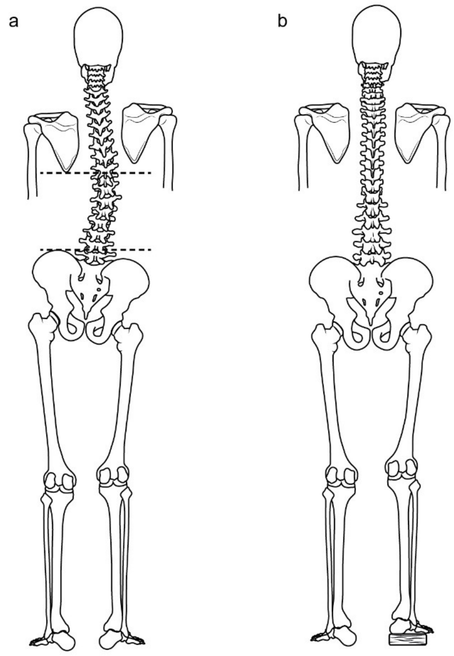
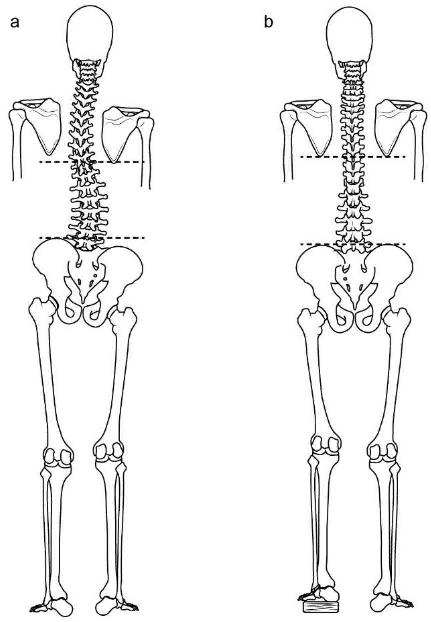


Figure 2. Upslip of left ilium causes elevation of an iliac crest, apparent shortening of the left leg, S-scoliosis with thoracic convexity to the left and elevation of the left scapulae. Lift under the left foot evens the iliac crests and straightens out the scoliosis, at least partially.



malalignments were added to the usual PRM examination: 1) a sagittal iliac asymmetry and 2) a sacral torsion around a diagonal axis.

The patients were instructed to perform two muscle-energy aligning maneuvers. Following performance of each maneuver, the level of iliac crests and inferior scapular angles were measured using a Palpation Meter (PALM®, Performance Attainment Associates, Roseville, MN, USA). This instrument has been found to be a valid, reliable, and precise tool for the measurement of scapular position, and pelvic crest height difference. Combining a caliper and an inclinometer, an estimate was made using a sine function slide ruler. A 12-mm thick wooden plate was subsequently used to compare the leg length in the upright position. The examination steps for iliac asymmetry and sacral torsion are demonstrated in Figures 1, 2, and 3. A detailed description of the restoration of pelvic asymmetries is provided in our previous study3, in addition to a video.

Step 1. Iliac asymmetry

Iliac crest height and scapula height were measured, and the antero-posterior position of the shoulders was compared. Leg length discrepancy was estimated in a supine position where the assessor placed their thumbs caudally to the medial malleoli and compared the subsequent position of each thumb. As demonstrated in Figures 1 and 2, if the difference in the level of iliac crests was observed, for further confirmation, a 12-mm elevation was placed in turn underfoot, and the iliac crest height was further compared.

Figure 3. Isolated sacral torsion with left sacral inferolateral angle more ventrally positioned, first visible after iliac asymmetry is aligned. It causes C-scoliosis with the left thoracic convexity and elevation of the left scapulae without affecting iliac crests or leg length.

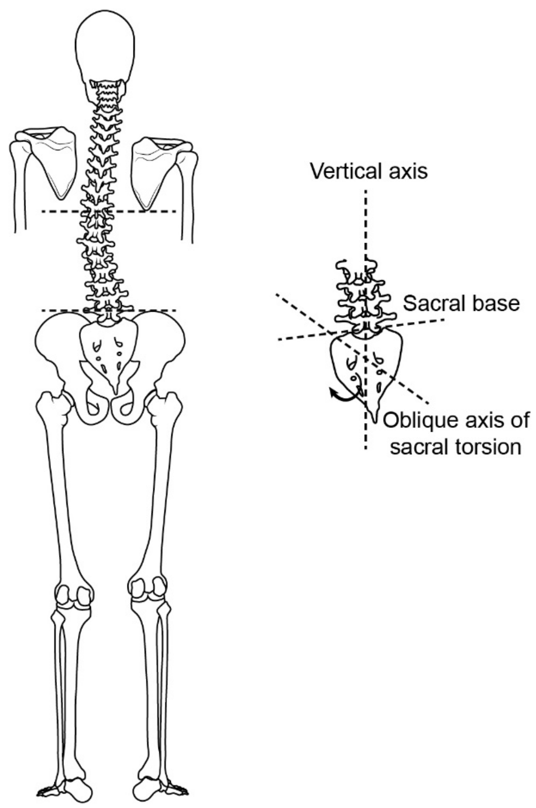


Figure 4. Practitioner led the head back to the neutral position

Step 2. Sacral torsion

Iliac crest level was re-assessed. If the ilia became even, using the maneuver described in our previous work 3 the observed symmetry was confirmed by placing 12-mm blocks under each foot to ensure an equal elevation in both iliac crests. The level of the inferior scapular angles was then measured, and the antero-posterior relationship of the lateral and inferior sacral angles and the shoulders were compared (Figure 3). If asymmetry was observed in all three aforementioned areas, sacral torsion was indicated; the patient was subsequently instructed to perform a sacrum aligning maneuver. The height of the scapular angles was measured in an upright position and the anteroposterior relationship of the lateral and inferior sacral angles and shoulders was reassessed.

The upper cervical spine was examined using two tests while patient was lying supine and with the examiner sitting behind the patient's head. First, the approximation between the transverse process of atlas and mastoid process was assessed bilaterally.

In case the palpable interspace between mastoid process and transverse process of atlas was unilaterally restricted, the atlas was mobilized using a modification of the method outlined by Lee, which utilizes the close functional affinity of eye movements with upper cervical muscles and does not require engagement of any outside force. E.g.: right approximation of the mastoid process to the transverse process of the atlas is observed; the aim of the technique is to extend and flex the right side atlanto-occipital joint. This can be accomplished as the patient lying supine head in neutral position, the practitioner supporting the cranium carefully flexes the head to the left to the point of restriction. The patient was then instructed to gaze, without turning the head, maximally to the left. for ca. five seconds, which recruits the left suboccipital muscles and relaxes the right. The practitioner led the head back to the neutral position and the same is performed thrice prior to reassessment. (Figure 4)

When the rotation of the atlantoaxial joint showed unilateral restriction, another variation of the same method outlined by Lee15 was used. E.g. in case Cervical Rotation Flexion Test (CFRT) was restricted to the left, the following mobilization was used. With the practitioner supporting the head in neutral position, carefully side flexes the head to the left to the point of restriction. The patient was then instructed to gaze without turning the head, maximally to the right. Deviation of the eyes to the right recruits the right suboccipital muscles reciprocally inhibiting the left. This procedure was repeated three times prior to reassessment. (Figure 5)

RESULTS

The age of the 104 patients ranged from 13 to 86 years, and 36 were men. Reversible pelvic asymmetry was found in 100 out of 104 patients (96%). Fifty-two patients had an anteriorly rotated ilium; 47 on the left side and five on the right. Forty-eight patients had an upslip; 41 on the left and seven on the right. Both asymmetries were associated with a higher ilium on the affected side. The average height difference between iliac crests measured using a PALM® tool was 20 mm (9-28 mm range). The average difference in the height of the scapular angles was 11 mm (0-18 mm range).

A simultaneous sacral torsion, which was first noticeable after adjusting the ilia, was observed in 98 patients. This condition does not cause functional LLD. Sacral torsion manifested by way of rotatory C-scoliosis with elevated scapulae and an anteriorly rotated shoulder on the side where the inferolateral sacral angle is more ventrally located (palpating thumb sinks deeper on that side). The difference in the height of the scapular elevation varied between 6 and 16 mm, with a mean of 9 mm. Scapular elevation caused by iliac asymmetry was predominantly found on the same side as the elevation caused by sacral torsion. However, in 36 cases, the scapular elevation caused by the sacral torsion was on the side opposite to that of the initial scapular elevation, so that after the adjustment of the ilium, scapular elevation changed sides. This finding explains the initial zero difference in the scapular level in the current cohort, as the two opposing types of scoliosis, one caused by iliac asymmetry and the other by sacral torsion, initially neutralized each other. The main functional features of the three pelvic asymmetries causing functional scoliosis can be summarized in that the iliac upslip shortens, and the

Figure 5. When Cervical Rotation Flexion Test (CFRT) was restricted to the left, a practitioner, supporting the head in neutral position, carefully side flexes the head to the left to the point of restriction. A patient was then instructed to gaze without turning the head, maximally to the right. Deviation of the eyes to the right recruits the right suboccipital muscles reciprocally inhibiting the left.

Table 1. Main functional features of pelvic asymmetry causing functional scoliosis

Position	Anterior rotation	Upslip
Standing with the body weight equally on both feet	Ipsilateral iliac crest and contralateral scapula, higher. Contralateral shoulder, more anterior	Ipsilateral iliac crest and scapulae, higher. Shoulder, more anterior.
Standing on a lift (height 12 mm) under the contralateral foot	Iliac crests are even	Contralateral iliac crest elevated
Standing on a lift (height 12 mm) under the ipsilateral foot	Ipsilateral iliac crest further elevated	Iliac crests are even
Lying in the supine position	Ipsilateral leg longer	Ipsilateral leg shorter

anterior rotation lengthens the ipsilateral leg and sacral torsion does not affect leg length. More detailed differences are presented in Table 1.

In all three asymmetries, the self-correcting muscle-energy maneuvers resulted in restoring symmetry of all the described features, without the use of shoe lifts. The prescribed maneuvers were also found to restore pelvic symmetry in all cases so that in the subsequent assessment the scapulae and shoulders were even. The change from obliqueness to symmetry and vice versa is clear like an on/off phenomenon without anything in between. The re-establishment of pelvic symmetry additionally resulted in LLD equalization.

A systematical interaction between the three separate features of pelvic obliquity and atlantoaxial positioning was noticeable. Anterior rotation of the ilium predominantly determined the side of the atlanto-occipital approximation and sacral torsion was determined by the side of restriction in the cervical flexion rotation test. The side of the iliac upslip was reflected on the side of cervical flexion rotation restriction and the sacral torsion determined the side of the atlanto-occipital approximation (Table 2.).

Despite the re-establishment of the visible pelvic and spinal symmetry, the atlanto-occipital and alanto-axial restrictions were regularly found to remain after the pelvic alignment. As a rule, both mobilization techniques diminished the two restrictions.

DISCUSSION

The aim of study was to observe the manifestations of the three known types of functional scoliosis, caused by pelvic asymmetry and their effects on the spatial relationship of the upper cervical vertebrae and to evaluate the results of establishing spinal symmetry using patients' own muscular strength.

In viewing the spine as a functional entity, pelvic asymmetries are reflected in three spinal segments up to the uppermost vertebrae. It can be presumed that the described variations of pelvic obliquity affect the sacral position in distinct ways, so that different positions of sacrum are reflected through the vertebral interplay to atlas and axis also in three distinct patterns. Research concerning the spine as a functional unity remains limited.

In their study concerning the accuracy of palpation in determining the location of transverse process of atlas using radiographic markers, Cooperstein et al. concluded that the inter-examiner and intra-examiner accuracy of palpatory evaluation was excellent. Second, a cervical-flexion-rotation-test (CFRT) was performed bilaterally to qualitatively compare the range of rotatory motion. The CFRT has proven to be a useful clinical measure of cervical movement impairment and can be used accurately and reliably by inexperienced examiners. Furthermore, the CFRT shows good sensitivity and specificity in the diagnosis of cervicogenic headaches.

The current work described the positioning of the two upper cervical vertebrae based on manual assessment and thus is liable to bias and error. However, the conclusive findings are so distinct that they must not be overlooked. The present work further underscores the reversible nature of pelvic obliquity resulting in functional scoliosis and LLD. The research provided support for the use of pelvic alignment in place of the current widespread approach which uses shoe lifts as the primary treatment for LLD.

Table 2. A summary of the interactions between the three forms of pelvic asymmetry and the position two first cervical vertebrae.

Position	Atlanto–occipital approximation.	Atlanto-axial rotation (CFR-test)
Anterior rotation of ilium	Restricted on the side of thoracic convexity, contralateral to the iliac anterior rotation, 94%.	Restricted on the side of the thoracic convexity caused by sacral torsion, 92%.
Upslip of ilium	Restricted on the side of the thoracic convexity caused by sacral torsion, 89%.	Restricted on the side of the thoracic convexity caused by upslip, ipsilateral to upslip, 88%

The author has used the described method for upper cervical alignment for more than 15 years in combination with the muscle energy techniques for pelvic alignment in treatment of long-lasting musculoskeletal conditions. No adverse effects have been observed. The strong mutual interdependency of upper cervical spine and pelvic asymmetry is demonstrated by the repeated observation that when cervical alignment is first performed it can lead to spontaneous pelvic alignment. However, the cervical asymmetries persist after the pelvic alignment emphasizing the importance of upper cervical alignment. Based on personal observation, functional scoliosis with LLD can first be asymptomatic in young age but still lead to serious complications in the long run as described by Sheha et. al.1. Considering the simplicity of the aligning treatment presented in this study, it could also be used as a prevention technique. In view of the high prevalence of pelvic obliquity, future research must investigate whether existing pelvic obliquity in adolescence could be a disposing factor in the etiology of idiopathic scoliosis.

In the data gained during 2018, the prevalence and distribution of the different manifestations of pelvic obliquity were closely aligned with the results of our first study undertaken in 2017, which lends more credence to the repeatability of the findings. The generalization of the results of the study might be limited by the fact that this was a retrospective study amongst patients treated by a single physician. As the same physician performed all of the assessments, further research is needed to confirm the observed results. Controlled studies with at least single-blinded design are required to verify the effects of maneuvers suggested by the current study findings. Further, limited possibilities of clinical examination place restrictions on the outcome of this study.

REFERENCES

1. Sheha ED, Steinhaus ME, Kim HJ, Cunningham ME, Fragomen AT, Rozbruch SR. Leg-Length Discrepancy, Functional Scoliosis, and Low Back Pain. J Bone and Joint Surgery Reviews 2018;6(8):1-8)
2. Raczkowski JW, Daniszewska B and Zolynski K. Functional scoliosis caused by leg length discrepancy. Arch Med Sci 2010; 6: 393-398
3. Timgren J. Role of pelvic asymmetry in skeletal posture. PRM+ 2018;1(1):24-27 Available at http://prmplus.com/ojs/index.php/prmplus/article/view/6
4. Schambeger W. The malalignment syndrome, diagnosing and treating a common cause of acute and chronic pelvic, limb and back pain. London Churchill Livingstone; Second edition 2013.
5. DonTigny RL. Mechanics and treatment of the sacroiliac joint. In: Vleeming A, Mooney V, Dorman T, Snijders R, editors. Movement, stability & low back pain. New York7 Churchill Livingstone; 1999. p. 461-76
6. Rondeau W. The Accuracy of the Palpation Meter (PALM) for measuring scapular position in overhead athletes, dissertation. Chapel Hill: University of North Carolina; 2007
7. da Costa B, Armijo-Olivo S, Gadotti I, Warren S, Reid D, Magee D. Reliability of scapular positioning measurement procedure using the Palpation Meter (PALM). Physiotherapy 2010;96(1):59-67
8. Petrone M, Guinn J, Sutlive T, Reddin, A, Flynn TW, Garber MP. The accuracy of the Palpation Meter (PALM) for measuring pelvic crest height difference and leg length discrepancy. J Orthop Sports Phys Ther 2003;33(6):319-25
9. Hagins M, Brown M, Cook C, et al. Intratester and Intertester Reliability of the Palpation Meter (PALM) in Measuring Pelvic Position. The Journal of Manual & Manipulative Therapy. 1998;6(3):130-136
10. Azevedo D, Santos H, Carneiro RL, Andrade GT. Reliability of sagittal pelvic position assessments in standing, sitting and during hip flexion using palpation meter. J Bodyw Mov Ther 2014;18(2):210-4
11. Timgren J, Self correcting muscle energy maneuvers [Video file] 2018, June 20. Available from https://www.youtube.com/watch?v=ZvaHvXKkhY0&t=9s
12. Lee D. Principles and practice of muscle energy and functional techniques. In: Boyling J, Palastanga N, editors. Grieve's modern manual therapy. 1st ed. Edinburgh: Churchill Livingstone; 1986. p. 640-55
13. Cooperstein R, Young M, Lew M. Validity of palpation of the C1 transverse process: comparison with a radiographic reference standard. J Can Chiropr Assoc. 2015;59(2):91–100
14. Ogince M, Hall T, Robinson K, Blackmore AM. The diagnostic validity of the cervical flexion-rotation test in C1-C2 related cariogenic headache. Man Ther. 2007;12(3):256–262
15. Hall, T.M., Robinson, K.W., Fujinawa, O., Akasaka, K., Pyne, E.A., 2008. Intertester reliability and diagnostic validity of the cervical flexionrotation test. Journal of Manipulative and Physiological Therapy 31 (4), 293–300

ACKNOWLEDGEMENTS
The author wishes to express his gratitude to Elsevier Illustration services for developing the illustrations and to Elsevier Language services for editing of the text.