Reversible Pelvic Asymmetry: An Overlooked Syndrome Manifesting as Scoliosis, Apparent Leg-Length Difference, and Neurologic Symptoms

Article *in* Journal of manipulative and physiological therapeutics · September 2006

DOI: 10.1016/j.jmpt.2006.06.024 · Source: PubMed

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Reversible Pelvic Asymmetry: An Overlooked Syndrome Manifesting as Scoliosis, Apparent Leg-Length Difference, and Neurologic Symptoms

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Abstract

Objective: The objective of this study was to investigate the occurrence of pelvic asymmetry in neurologic patients with symptoms not explained by their neurologic diagnosis.

Methods: We analyzed 150 consecutive neurologic patients referred to physiatric consultation based on their clinical examination findings.

Results: We observed pelvic asymmetry associated with either C-type or S-type scoliosis and apparent leg-length difference in 87% of the patients. Symmetry could be reestablished by all patients, although 15% showed immediate or imminent relapse. Maintenance of symmetry showed a highly significant ($P < .001$) correlation with improvement in functional ability and reduction of pain as evaluated during the last visit to the physiatrist. In the follow-up questionnaire, 78% of the patients reported improvement in functional ability and reduced pain.

Conclusions: Our results support the view that leg-length difference and scoliosis may be more often of reversible nature than previously considered. Acquired postural asymmetry of the sacroiliac joint may be a neglected cause of several neurologic and other pain-related symptoms that can be relieved by a simple and safe treatment. (J Manipulative Physiol Ther 2006;29:561-565)

Key Indexing Terms: *Leg-length inequality; Scoliosis; Sacroiliac joint*

Common causes of postural asymmetry include leg-length difference, pelvic obliquity, and scoliosis. According to current clinical practice, radiologic or ultrasound examination has been used to assess leg-length difference. If differences in the level of the proximal ends of the femur or the ceiling of the acetabulum are observed, then differences in the bone length of the extremities are presupposed. Pelvic asymmetry is often caused by a dysfunctional sacroiliac (SI) joint.[1] Unilateral rotatory malposition of the SI joint has also been referred to as subluxation, upslip,[2] or compressed SI joint rotated anteriorly or posteriorly.[3] Scoliosis (ie, abnormal lateral curvature of the vertebral column) is considered to be most often structural and of spinal origin.

The cited separate features of postural asymmetry have been studied over the past 90 years. However, the biomechanical interdependence of the 3 factors and even more so their clinical significance in causing symptoms are still controversial and clinical studies are lacking. Interdependence is called for, for example, by observations that innominate rotation inevitably brings about a tilted sacrum and that an uneven sacral base results in a compensatory lateral curve of the spine. The relation of postural asymmetry and clinical symptoms is under discussion. A positive correlation between low-back pain and leg-length difference and/or innominate rotation has been shown by some studies,[4,5] whereas it remains a contentious issue in others.[6-8]

Pelvic asymmetry is common among symptomatic and asymptomatic persons.[1,7] No information is available on the prevalence of lateral curvature caused by unilateral innominate rotation. Because some patients showing asymmetry are asymptomatic, their abnormal posture is not predictive of pain. Although the correlation of asymmetry to symptoms such as low-back pain has remained contradictory, reestablishment of symmetric posture by applying a foot lift has resulted in significant relief from pain in symptomatic patients.[4,9]

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Paper submitted October 24, 2005; in revised form February 28, 2006; accepted April 26, 2006.

0161-4754/$32.00

doi:10.1016/j.jmpt.2006.06.024

This study's population consisted of neurologic patients remitted to physiatric consultation because their symptoms were not readily explained by neurology. The purpose of this study was to investigate the interdependence of leg-length difference, pelvic asymmetry, and lateral curvature of the spine and their possible relation to patients' symptoms.

Methods

The study group consisted of 150 consecutive neurologic patients of the Helsinki University Central Hospital Department of Neurology referred to physiatrist consultation between June 2001 and June 2003. This study was approved by the Helsinki University Central Hospital Ethical Committee.

In addition to routine physiatric clinical examination, special attention was given to asymmetry of the pelvis and spine. Differences between the left side and the right side in the level of the inferior angles of the scapulae and in the iliac crests were manually assessed in the neutral standing position. Elevation of the iliac crest and the ipsilateral scapula is referred to as S-type scoliosis, whereas elevation of the iliac crest and contralateral scapula is referred to as C-type scoliosis (Fig 1A and B). The estimation was repeated with 10- to 15-mm elevation under both feet in turn, and the change in asymmetry was registered. Tenderness of SI joints was estimated by applying local pressure, by thigh thrust, and with Patrick's test and other tests, such as iliac gapping, pelvic compression, and Gaenslen's test. The reliability of each of these tests has been discussed previously.[10]

Atlantooccipital function was assessed in two ways: (1) symmetry of head rotation in cervical flexion was observed and (2) the relative distance between the mastoid process of the temporal bone and the transverse process of the atlas was manually assessed bilaterally in cervical extension. Both examinations were performed with the patients in the supine position.[11]

Those patients showing pelvic asymmetry caused by dysfunction of the SI joint received one of two treatment options: (1) high-velocity and low-amplitude thrust technique applied through the ankle on the side of the dysfunctional SI joint or (2) restoration of symmetry by the self-embracing muscle energy technique. In this procedure, a patient resists thigh extension, alternating on both sides, to produce a corrective rotational force on the pelvis. Both methods have been described in detail elsewhere.[3,12] The estimation of asymmetry as described was repeated after the corrective treatment.

The patients had 1 to 13 (average, 3.7) appointments with the physiatrist. Some patients had several appointments as a result of continuing symptoms and failure in establishing symmetry. Treatments by a physiotherapist were not applied. During the last visit, the physiatrist evaluated the patients' response to the treatment in terms of functional ability, pain, and pain medication. A semiquantitative scale from 5 to 1 was used: significant improvement, moderate improvement, no response, moderate deterioration, or significant deterioration. Maintenance of symmetry was correlated with the treatment response by a 4-field matrix (improvement, no improvement, maintenance of symmetry, or relapse of asymmetry). Statistical analysis was performed using a χ^2 test.

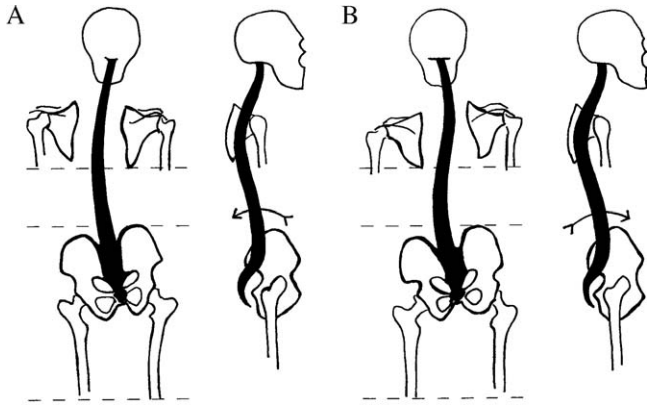

Fig 1. *Two types of SI-joint dysfunction related to reversible pelvic asymmetry were observed. A, Elevated iliac crest, ipsilateral posterior rotation of the innominate combined with an apparently longer leg on the same side, C-type lateral curvature of the spine, and higher contralateral scapula. B, Elevated iliac crest, ipsilateral anterior rotation of the innominate combined with an apparently shorter leg on the same side, S-type lateral curvature of the spine, and higher ipsilateral scapula.*

Subsequently, the patients were asked about their response to the given treatment using a questionnaire and by applying the same parameters and scale as described. The duration or continuation of the effect was also asked. The follow-up period (from the last appointment to the time the questionnaire was answered) varied from 5 to 26 months.

Results

The presenting symptoms of the patients were lumbosacral pain (n = 55, of whom 22 had pain radiating to the lower extremity), neck and shoulder pain (n = 31), headache (n = 25), extremity paresthesia (n = 23), dizziness (n = 12), other extremity pain (n = 15), thoracic pain (n = 9), pelvic pain (n = 6), facial paresthesia (n = 5), and limb weakness (n = 3). Duration of the symptoms varied: more than 10 years in 27 patients; 5 to 10 years in 18; 1 to 5 years in 57; and less than 1 year in 26.

Of the 150 patients, 130 (87%) presented with asymmetry of the pelvic girdle, resulting in a difference between iliac crest levels, which could be observed by posterolateral palpation. For most of the patients, one or more of the SI-joint pain provocation tests applied yielded positive findings for the side of the elevated crest level. Pelvic asymmetry was invariably associated with changes in the spine and apparent leg length. All patients showing pelvic asymmetry exhibited lateral spinal curvature. Seventy-eight

Table 1. *Correspondence of maintained symmetry observed by the physiatrist and significant or moderate improvement of condition reported by the patients during their last appointment (n = 125 [5 patients missed the control])*

	Maintenance of symmetry	Relapse of asymmetry
Improvement (n)	87	0
No improvement (n)	19	19
Total (n)	106	19

The correlation between maintained symmetry and response is highly significant ($P < .001$).

patients showed a C-type scoliosis (Fig 1A), whereas 52 did an S-type scoliosis (Fig 1B). The patients with C-type scoliosis exhibited apparent lengthening of the leg on the side of the elevated crest, whereas the patients with S-type scoliosis showed apparent shortening of the leg on the side of the elevated crest.

Placing a 10- to 15-mm lift under each foot in turn resulted explicitly in two types of response. In the patients with C-type scoliosis, a lift on the side of the elevated crest resulted in a clearly increased crest-level difference and correspondingly an equal lift on the opposite side resulted in leveling out of the difference. Paradoxically, in patients with S-type scoliosis, a lift on the side of the elevated crest resulted in leveling out of the crest-level difference and an equal lift on the opposite side resulted in reversed asymmetry, such that the crest, originally lower, was elevated with respect to the other side.

All patients showing pelvic asymmetry also showed asymmetric atlantooccipital function manifesting in two patterns. The patients with C-type scoliosis exhibited narrowing of the gap between the mastoid process and the transverse process of the atlas observed in cervical extension on the side opposite to the elevated crest. In these patients, cervical rotation performed in flexion was symmetric. In contrast, patients with S-type scoliosis showed restricted cervical rotation performed in flexion on the side of the elevated crest, whereas the atlantooccipital space in extension remained symmetric.

Pelvic asymmetry was of a reversible nature such that symmetry could be immediately reestablished by all patients, although relapse was observed during the same or a subsequent visit in 19 cases. Both of the corrective treatments applied were equally effective in reestablishing pelvic symmetry. In confirmation of the reversibility of the asymmetry, placing a lift under one foot in turn immediately after the treatment resulted in elevation of the iliac crest on the side of the lift equally on both sides.

Maintained symmetry or relapse of asymmetry and improvement or no improvement of condition, as evaluated during the last visit to the physiatrist, are shown in Table 1. Maintenance of symmetry and improvement of condition showed a highly significant correlation ($P < .001$). None

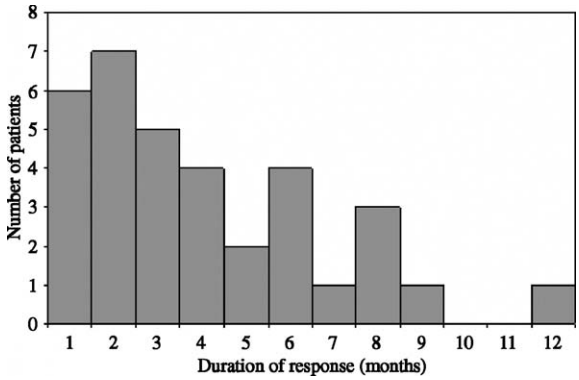

Fig 2. *Duration of response for those patients whose response was transient and who reported relapse of symptoms.*

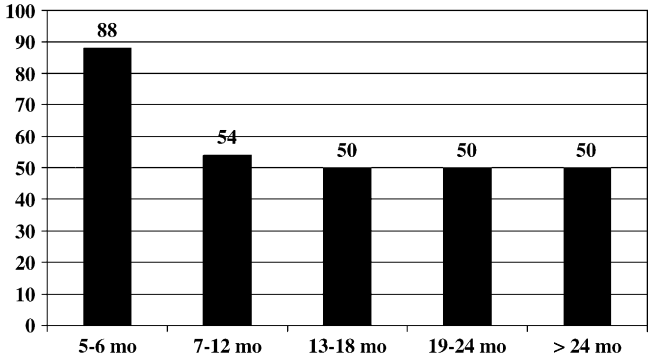

Fig 3. *The relative number of patients reporting significant or moderate improvement in their functional ability and pain reduction at the time they responded to the questionnaire is shown. The horizontal axis indicates the time from their last appointment to their follow-up questionnaire screening. In general, the figure shows the condition of the patients at the time they answered the questionnaire. Of the patients who received the questionnaire 5 to 6 months after their last appointment, 88% reported an improvement in their condition. Approximately half of the patients who received the questionnaire more than 7 months after their last appointment reported improvement.*

of the patients with relapsing asymmetry showed improved condition.

Of the 130 patients, 103 (79.2%) answered the questionnaire: 40.4% reported significant and 37.5% reported moderate improvement of functional ability and reduction of pain, whereas 19.2% reported no effect in functional ability and 18.2% reported no effect in pain. Fewer than 2% of the patients reported worsened ability or pain. Significant reduction and moderate reduction in pain medication were reported in 37.6% and 29.0% of the patients, respectively; 26.8% reported no change in medication and 6.5% reported increased medication. The condition of the patients at the time they answered the questionnaire is shown in Figure 2.

Of the patients who received the questionnaire 5 to 6 months after their last appointment, 88% reported

improvement in their condition. Of the patients who received it more than 7 months after their last appointment, approximately half reported improvement (Fig 3). No correlation was found between the length of the case history and duration of the response.

Discussion

In the present study, most of the ambulatory neurologic patients remitted to physiatric consultation exhibited pelvic asymmetry and irritation of the SI joint on the side of the elevated iliac crest. Mild asymmetry of the pelvis is common,[1,7] and contradictory results have been published on the correlation between asymmetry and symptoms.[4,9] The prevalence of pelvic asymmetry in a population without SI-joint problems is only 5.3%.[13] The measure used in the study by Badii et al[13] was the two-dimensional distance between the iliac crest margin and the femoral head (caput femoris) based on abdominal computed tomographic scans. However, because of the complexity of the spatial relations and biomechanics of the pelvis, assessment in two dimensions must be judged with caution. Our results support the view that pelvic asymmetry is clinically significant because reestablishment of symmetry correlated with diminishing symptoms.

Owing to biomechanics, the innominate is rotated anteriorly in patients whose anterior superior iliac spine (ASIS) on the side of the elevated crest is lower than its contralateral counterpart and, respectively, whose posterior superior iliac spine (PSIS) on the side of the elevated crest is higher than the contralateral PSIS. In analogy, the innominate is rotated posteriorly if the ASIS on the side of the elevated crest is higher than the contralateral ASIS and if the PSIS on the side of the elevated crest is lower than the contralateral PSIS. In our material, innominate rotation was unexceptionally associated with asymmetry of the spine such that the patients with posterior rotation showed C-type scoliosis and the patients with anterior rotation showed S-type scoliosis.

Asymmetry of the pelvis was consistently correlated with radiologically observed 2° to 4° of obliquity of the sacrum by those patients who had been radiologically examined. A corresponding tilt was observed in a cervical x-ray examination: the atlas was elevated on the side contralateral to the elevated iliac crest in C-type scoliosis, whereas the opposite was observed for S-type scoliosis.

Posterior and anterior rotations of the innominate raise the ipsilateral iliac crest.[3] Thus, innominate rotation is associated with an apparent difference in leg length. Our consistent observations were that placing a lift under the foot on the side of the elevated crest resulted in a further increase in iliac crest difference in patients with posterior rotation and C-type scoliosis and that placing a corresponding lift leveled out the difference in patients with anterior rotation and S-type scoliosis. Rising of the iliac crest upon posterior innominate rotation can be explained by lengthening of the leg. Rising of the crest upon anterior SI rotation is paradoxical, and its explanation cannot be reduced to a two-dimensional model. We suggest that rotation of a hypermobile SI joint results in minute interdependent movements in several other joints, including the symphysis, femoral joint, and the facet joints, and that the direction of rotation determines which of the two patterns described is the net effect.

The atlantooccipital junction showed abnormal movement depending on the type of curvature: C-type scoliosis was associated with a widened atlantooccipital gap observed in cervical extension on the side of the elevated crest, whereas S-type scoliosis was associated with restricted rotation in flexion on the side of the elevated crest. Tilting of the atlas in the frontal plane caused by scoliosis does not alone explain this observation. We conclude that the atlas is subject to torsion movement such that the posterior atlas is relatively descended in C-type scoliosis and the anterior atlas is relatively elevated on the side of the elevated crest in S-type scoliosis.

A correlation between innominate rotation and apparent leg-length difference has been shown in a study reporting that imposed leg lengthening in healthy volunteers causes posterior innominate rotation on the side of the lift and anterior rotation on the opposite side.[14] Shamberger[15] recently described a malalignment syndrome consisting of innominate rotation, elevation of the iliac crest, and compensatory scoliosis. Our study further characterizes this concept by presenting evidence that innominate rotation results in a syndrome manifesting in two forms depending on the direction of innominate rotation.

The reversible nature of the syndrome described in the present study is shown by the fact that the corrective treatments resulted in immediate reestablishment of symmetry in all patients, although an imminent relapse occurred in 15% of the patients. Thus, the lateral curvature of the spine observed in the present study does not represent structural (congenital or idiopathic) scoliosis. It is possible that SI-joint ligament laxity in connection with a single blow or repeated microtrauma may result in innominate rotation and consequently lead to the syndrome described. In this study, iliac crest symmetry was manually assessed. After closing the study, the use of a pelviometer[16] applied on corresponding patients confirmed the said observations.

During the first period of the study, 85% of the patients maintained symmetry when they were under the physiatrist's control, and 82% of these patients reported significant relief from pain and improvement of function. On the other hand, 15% of the patients failed to maintain symmetry, and none of these patients reported relief from pain or improvement of function. Although 18% of the patients who maintained symmetry did not report improvement, the association between symmetry and improvement was significant. These observations suggest that pelvic asymmetry is a contributing factor in several symptoms of

neurologic patients. The observation that none of the patients who failed to maintain symmetry reported improvement strongly suggests that placebo effect does not significantly contribute to the treatment response.

The relative number of responders among patients receiving the questionnaire 5 to 6 months after their last appointment was of the same magnitude as that at the last appointment (>80%). Of the patients receiving the questionnaire at a later time, approximately half reported relief from pain and improved function regardless of the length of follow-up. Although symmetry was not assessed at the time the questionnaire was given, we presume that most patients maintained symmetry because relapse of asymmetry was never associated with an improved condition during the first phase of the study. Notably, the response to the treatment did not depend on the duration of the symptoms.

The mechanism by which asymmetry might cause various neurologic symptoms is speculative. The dural sac is anchored to the vertebral column at two points, suboccipitally and in the sacrum. The dural sac continues around spinal nerves, surrounding them as an intimate sheath. These facts support the idea that asymmetric posture might result in pathologic tension of the meninges, spinal cord, and even brain stem.[17] Degenerative changes in the vertebral column may exacerbate the effects of such tension.

Conclusion

These preliminary findings suggest that an acquired postural asymmetry of the SI joint is a common, although often neglected, cause of various neurologic and other pain-related symptoms and can be relieved by a simple and safe treatment.

Practical Applications

- A reversible pelvic asymmetry was observed in 87% of 150 consecutive neurologic patients referred to physiatric consultation.
- C-type scoliosis was consistently associated with ipsilateral posterior rotation of the innominate and apparent leg lengthening on the same side.
- S-type scoliosis was associated with ipsilateral anterior rotation of the innominate and apparent leg shortening on the same side.

Acknowledgment

This study was funded by the Helsinki University Central Hospital through research grant no. T1050NL317.

The authors thank Mrs Tuuli Autio for drawing Figure 1, Ms Minni Lajunen for her secretarial help, and Ms Inari Soinila for revising the language.

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