Orthotic compensation for leg length inequality (OCLLI)

Our experience with orthotic compensation for leg length inequality in the treatment of scoliosis

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Abstract

Our patient population includes many scoliosis patients with orthotic compensation for leg length inequality (OCLLI) due to functional tilting of the pelvis. In such cases the desired correction is hardly ever achieved because – as a reaction to OCLLI – compensatory movements occur in the pelvis and spine. Only anatomical leg length inequality justifies OCLLI. This can be identified clinically by the lower than usual positions on the same side of the ventral and dorsal iliac spines, the iliac crest, trochanter and sacroiliac joints. In addition, a corresponding sacral tilt is evident on radiography.

After precise observation of the findings, a functional pelvic tilt can be actively corrected by physiotherapy. Where it is necessary, OCLLI should never be omitted. However, premature provision of OCLLI may often achieve the very opposite of the desired correction. This also applies when OCLLI is prescribed to improve the fit of a brace. Three-dimensional assessment of pelvic position by the therapist and subjective acceptance on the part of the patient are always important.

Patients with various spinal deformities are treated by physiotherapy in our clinic. In adition to scoliosis (primarily idiopathic scoliosis) with very varied curve patterns, we also treat patients with postural degeneration and Scheuermann's disease.

Many of our patients with functional pelvic tilt have been supplied with orthotic compensation for leg length inequality (OCLLI). We consider such provision to be harmful in many cases and would like to present our experiences in this field for discussion here.
During the initial examination at the Katharina **Schroth** Clinic, pelvic status is assessed using the following clinical signs:

I Anal cleft, gluteal folds
II Palpation of:
    1. dorsal iliac spines
    2. iliac crests with pelvic "spirit level"
    3. sacroiliac joints
    4. greater trochanter on both sides
    5. ventral iliac spines
III Evaluation of standing AP whole-body X-ray.

Lateral deviation of the pelvis seems to be particularly pronounced in severe cases of scoliosis. One hip is prominent laterally, appears to stand higher and the leg on that side appears to be longer. This lateral deviation of the pelvis necessitates the deployment of compensatory counter-forces in a cephalad direction with one or two counter-curves of the spine in the shoulder-neck region.
We refer to a "scoliotic equilibrium" with pelvic tilt.

The aim of three-dimensional scoliosis treatment according to **Schroth** is to improve body statics and to transform this "scoliotic equilibrium" into an approximately normal body equilibrium.

Figure 1: 12-year-old girl with idiopathic three-curve scoliosis with convexity to the right, and left hip prominence. The weight of the body rests on the right leg

Figure 2: OCLLI placed under the right foot narrows the right lumbar region and shifts the lumbar curve to the left.

Figure 3:
Schroth exercise without OCLLI: "Pressing in" the left hip. The upper body is moved to the left, and the right waist area is opened up because now the weight of the body is resting on the left leg. The pelvis is level.

Figure 4:
The same patient during a back-stretching strengthening exercise with two bars. Now the correction is slightly more successful.

This means arranging the pelvis, ribcage and shoulder girdle over the centre of gravity so that neither hip is prominent any longer. In this instance the height difference between the iliac crests also appears to be compensated in most cases because only a functional pelvic tilt may have been present.

OCLLI in functional three-curve scoliosis

(Figures 1, 2, 3 and 4)

Functional three-curve scoliosis is usually thoracic scoliosis, and in many cases there may also be a double major curve. According to **Schroth**, the term "three-curve" refers to the three trunk segments (pelvic girdle, ribcage, shoulder girdle) in scoliosis that are displaced and torsioned sometimes in the frontal, sometimes in the sagittal and sometimes in the transverse plane. The pelvis and shoulder girdle are displaced in the same direction, and the interposed thoracic segment in the opposite direction. The hip on the thoracic concave side is prominent and appears to stand higher. The patient has hardly any lumbar hump.

The lumbar curve transitions vertically into the anal cleft. The weight of the body rests increasingly on the leg on the thoracic convex side.

Figure 1 shows a 12-year-old girl with functional three-curve idiopathic scoliosis with thoracic convexity to the right, lumbar convexity to the left and a compensatory cervical curve. Her left hip is prominent. Her body weight rests increasingly on her right leg. In this case OCLLI on the right side would straighten the upper body a little. However, this would be achieved at the expense of increasing the lumbar curve. The narrowing beneath the rib hump on the right side would be amplified (Figure 2).

According to **Schroth**, correction should be achieved by "pressing" the left hip inwards from the outside of the left thigh (greater trochanter) (Figures 3 and 4) so that the right hip moves laterally (static over-correction). However, this is not possible without weight displacement on to the left leg. As a result, for reasons of equilibrium, the upper body must also compensate by inclining to the left (not bending = becoming narrow). The right heel must remain on the floor or strive to do so. This results in widening of the concavity on the right side beneath the rib hump and in straightening of the lumbar curve. OCLLI is not necessary in this case.

OCLLI in functional four-curve scoliosis with a compensatory lumbosacral curve

(Figures 5 to 8)

The term "four-curve" refers to the shoulder-neck segment, ribcage segment, lumbar segment and pelvic segment of the trunk. In this form of scoliosis a pronounced lumbar hump is a noteworthy finding and this is often larger than the thoracic rib hump.

The relatively high lumbar curve transitions caudally into a compensatory lumbosacral curve that swings over to the thoracic convex side. Simultaneously, the prominent hip on the thoracic convex side appears to be higher. The weight of the body rests increasingly on the leg on the thoracic concave side (Figure 5).

Figure 5: 24-year-old woman with idiopathic four-curve scoliosis: cervical convexity to the left, thoracic convexity to the right, lumbar convexity to the left and lumbosacral convexity to the right again. The prominent hip is on the right side. The anal cleft is slightly oblique. Her pelvis appears to be higher on the right side and torsioned = on the right side upwards and backwards, on the left side forwards and downwards. Her gluteal folds are almost horizontal.

Figure 6: The same patient with an OCLLI (2 cm, left). In terms of height the pelvis appears to be almost levelled. The anal cleft is slightly more oblique. The popliteal fossae are no longer on the same level. The gluteal folds are also at different heights.

OCLLI on the left side in this case would amplify the compensatory lumbosacral curve and pull the pelvis further into an incorrect position (Figure 6). For static correction the centre of gravity must be returned to the midline. For this reason, the right hip is "pressed" inwards from the right thigh (greater trochanter) (Figure 7). In this position the patient now practises walking (Figure 8).

If we consider these two manifestations of scoliosis, the deviation in the frontal plane is the most striking. In both cases we are dealing with scoliosis with thoracic convexity to the right and a compensatory lumbar curve. However, the functional treatment of the two postural anomalies is basically different because the lateral deviation of the pelvis is also different in both cases. The clinical picture of both scoliosis forms unfortunately often leads to premature provision of OCLLI on the side of the hip that appears to be lower. Our observations indicate that a functional pelvic tilt of this kind cannot be corrected by simply placing OCLLI beneath the foot. An OCLLI placed on the side of the apparently lower pelvis may give the optical impression of levelling the pelvis, but because the load on the leg remains unchanged, this may considerably amplify the lumbosacral as well as the cranial curves. This is particularly pronounced in the individual step phases while walking and further scoliotic movement patterns may become evident.

Functional treatment in this context must take the opposite path and correct the pelvic positional anomalies in all planes described. Once the patient has made all the necessary pelvic corrections, i.e., once the pelvis is in its proper position, OCLLI will tend to have a disruptive effect on the new postural pattern to be acquired.

The aim of **Schroth** three-dimensional scoliosis treatment is to modify the previously described scoliotic equilibrium by eliminating scoliotic body statics. This starts by making the patient accustomed to altered leg loads while incorporating targeted pelvic corrections. Thus the desired corrected pelvic and spinal position is achieved in a functional manner through exercise. For this to happen, the pelvic and hip muscles must be summoned into the patient's consciousness so that he/she can work with them. The corresponding sensations of tension during the exercise have to be internalised in order to improve postural awareness. OCLLI is therefore not indicated here.

Figure 7: The patient "exercises her right hip inwards" by pressing her left hip against the table with simultaneous slight external rotation of her left thigh. Against this, the left lumbar hump is derotated forwards, upwards and inwards with manual assistance. OCLLI is not necessary, the pelvis is horizontal, and the anal cleft is perpendicular.

Figure 8: In this correction the patient now walks with subjective feeling that is complemented by mirror control.

OCLLI in conjunction with a brace

When a brace is supplied, OCLLI is occasionally prescribed to ensure that the brace has a better perpendicular fit (Figures 9 to 12). However, this is achieved at the expense of an artificial pelvic tilt. We believe that before the plaster cast is made to prepare the brace, the patient must learn to adopt corrective pelvic positions (Figures 13 to 15). This will then certainly result in more effective brace provision.

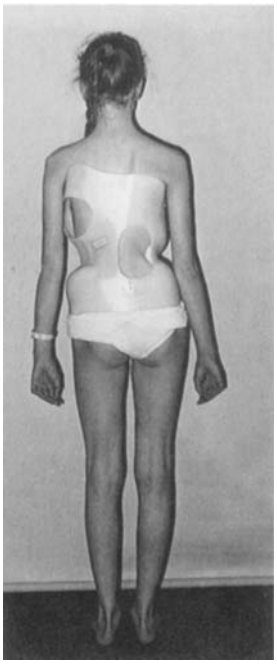


Figure 9: 12.5-year-old girl wearing a Chéneau brace. Without OCLLI her upper body falls to the left. The weight of her body is resting on the left leg. Her right hip protrudes laterally.

Figure 10: Her upper body becomes more upright following placement of OCLLI (2 cm, left). However, the gluteal folds are now no longer level = left higher than right.

OCLLI in pelvic torsion

(Figures 16 and 17)

This pelvic anomaly is mostly encountered in scoliosis with a compensatory lumbosacral curve and can sometimes also be recognised on X-ray. Clinically, the pelvis on the thoracic concave side (lumbar hump side) is torsioned forwards and downwards. On X-ray the ilium on this side appears to be narrower. Because the pelvis on the thoracic convex side is torsioned upwards and backwards, the ilium on this side appears broader on X-ray. The same applies for the sacroiliac joint oval.

On a sufficiently wide X-ray lateral deviation of the pelvis can also be detected if a plumb line is dropped from both sides of the chest wall. Because pelvic torsion is often caused by asymmetric muscle tension, consideration should first be given to using physiotherapy to correct the lateral deviation of the pelvis and pelvic torsion. According to *Eder* and *Tilscher* (1988) as well as *Lewit* (1970) the iliopsoas muscle is believed to play a role here. After appropriate functional treatment, the height difference evens itself out in most cases. OCLLI becomes superfluous.

Because sacral tilt visible on X-ray may be caused by pelvic torsion, it is imperative to perform a precise clinical examination.

Figure 11: The same patient without a brace. The upper parts of the ilium are not level, and neither are the gluteal folds: right side higher. The waist triangle on the left side is flattened. The right hip is prominent. The pelvis appears to be torsioned:
upwards and backwards on the right side, forwards and downwards on the left side.

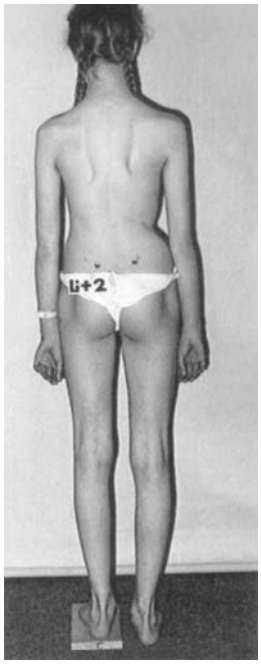


Figure 12: An OCLLI (2 cm, left) does not fully correct this pelvic tilt. However, the right hip is no longer as prominent. The waist triangle on the left side reappears.

Figure 13: The same patient "exercises her right hip inwards" and uses rotational angular breathing to move the false ribs on the right side laterally-upwards and backwards-upwards. She reinforces the correction result by exerting isometric pressure with the bars against the floor. The gluteal folds are now horizontal and her hips are more level.

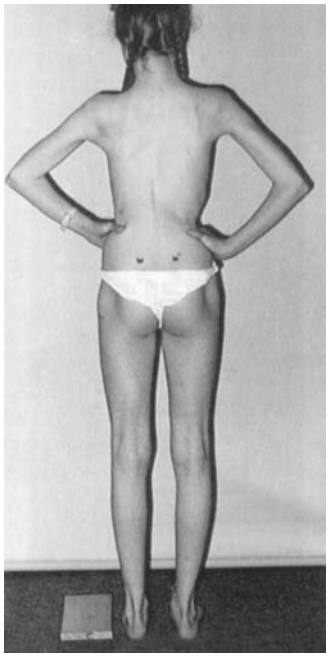


Figure 14: The patient also practises the correction result without bars but with hip support. Same effect as illustrated in Figure 13.

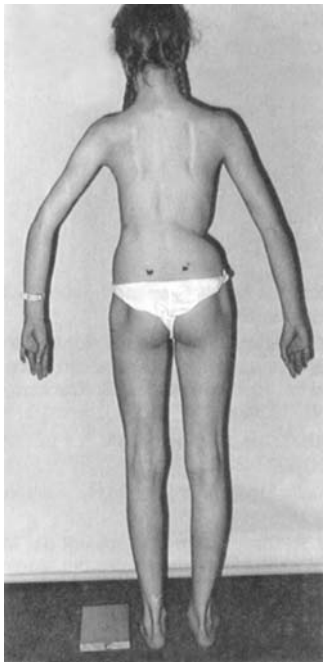


Figure 15: The patient attempts, without bars and manual support, to achieve the same pelvic correction with the same result, but using subjective feeling and mirror control. The result is not yet 100%.

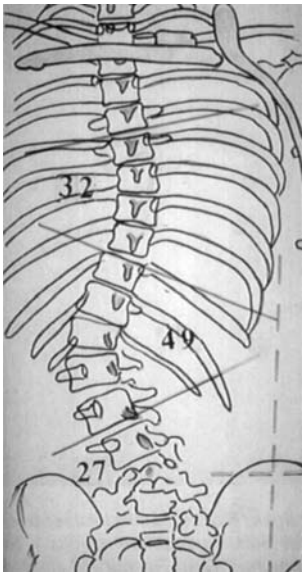
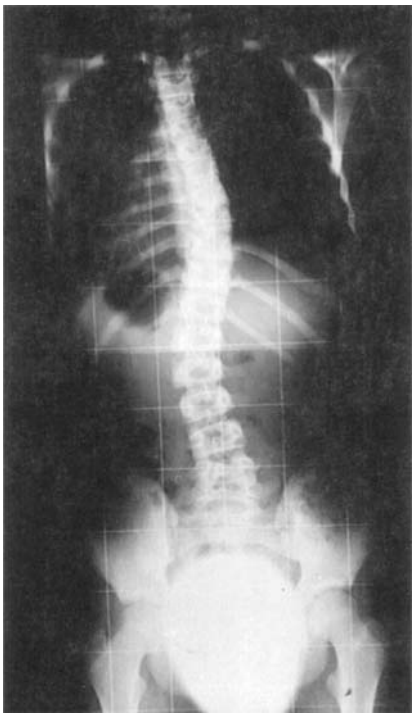


Figure 16: Drawing of the X-ray of the 12.5-year-old patient wearing a brace. Pelvic torsion is recognisable from the broader appearance of the upper part of the right ilium. This shows upward and backward torsion. The apparently narrower left ilium displays forward and downward torsion. Her upper body is inclined to the left side. A plumb line from the axilla "intersects" the right hip by several centimetres whereas a plumb line on the left side hangs several centimetres wide of the hip.



OCLLI in pelvic tilt with anatomical leg length inequality

In the event of anatomical leg length inequality, the difference in height between the upper parts of the ilium cannot be evened out by physiotherapy. In these circumstances OCLLI is justified. Sacral tilt is evident on X-ray, and pelvic torsion can be identified only rarely on clinical examination. However, there are rare cases of leg length inequality where OCLLI can be dispensed with.

Figure 17: X-ray of a 10-year-old girl, idiopathic scoliosis with mild lumbosacral spinal curve with convexity to the right. The whole upper body leans to the left because her body weight is resting on her left leg. Therefore her right hip also protrudes laterally and s "intersected" by a plumb line from the axilla. On the left side the plumb line falls wide of the hip.

Namely, where OCLLI compensates for the difference in height between the upper parts of the ilium but pushes the lumbar spine into its curvature (Figure 18).

Even with standing AP X-rays it cannot always be established with certainty whether anatomical leg length inequality is present or pelvic torsion in the frontal plane. For this reason, inspection and palpatory findings are indispensable here.

Where anatomical leg length inequality is verified by measurement and X-ray assessment, OCLLI must also be worn when performing corrective physiotherapy exercises.

In puberty, pelvic tilt due to anatomical leg length inequality often disappears after a few months by wearing OCLLI. This can perhaps be explained by postulating a developmental stimulus to the shorter leg. Tests to establish the necessity for OCLLI should therefore be performed at regular intervals. For completeness it may also be mentioned that the spine in its totality may be impaired in its static reactivity by blockade of joints, including those in the head.

Tomaschewski has described scoliosis patients with blockades of the sacroiliac joints, lumbar spine or cranial joints which, as demonstrated on X-ray, respond entirely differently to compensation for leg length inequality.

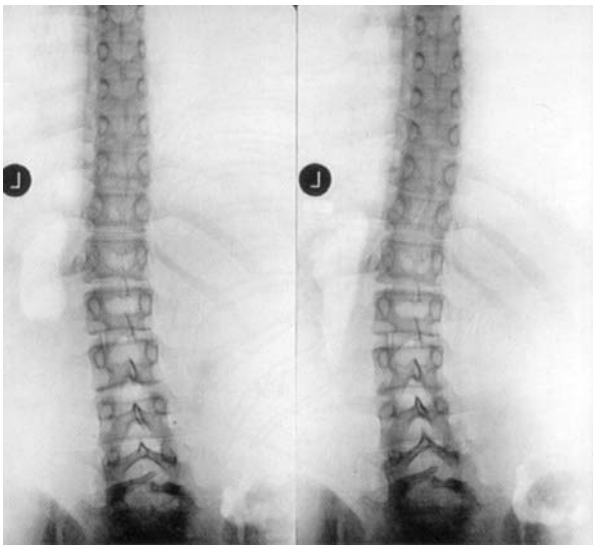


Figure 18: 13.3-year-old girl. Left: mild pelvic tilt due to anatomical leg length inequality (1 cm, left). Lumbar curve: 9 degrees.
Right: With an OCLLI of 1 cm on the left side, the spine is shifted in the wrong direction: lumbar curve 16 degrees. In addition, the thoracic curve becomes larger. Therefore OCLLI must not be implemented in this case.