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Leg Length Inequality

A prospective study of young men during their military service

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ABSTRACT

Within a prospective study of back function and pain before and after basic military training, the leg length inequality (LLI) was assessed, in steps of less than 0.5 cm. (equal), 0.5-1.5 cm, 1.6-2.5 cm, 2.6-3.5 cm and more than 3.5 cm. Around six hundred young men were examined three times over a period of four years. LLI of 0.5-1.5 cm was found in 32%, and 4% had a difference of over 1,5 cm. Pelvic rotation was noted in 15% of the cases. The average total agreement of identifying LLI was 64% between the three examinations. No correlation was found between LLI and back-pain or pain-provocing tests. In those with LLI in standing there was a tendency towards more remarks on SI-joint mobility tested in lying. During the follow-up period, no correlation of the LLI and the result of the other examination variables could be found.

INTRODUCTION

Assessing leg length inequality (LLI) in standing is widely used as part of the examination in cases with back pain (5,8,9,11,14,15,16,23). There is no agreement however about the value of the assessment nor about the limits for normality. Indeed some authors hardly mention the assessment at all (13,18,20).

Standing roentgenograms are probably the most reliable method for the measurement of leg length inequality, but such are not easily accessible for routine clinical use. Friberg (9) uses a modified x-ray method that gives a very small dosage of radiation. The exposure is only on the femoral heads and acetabuli, and their levels are compared. Screening-studies of LLI with other x-ray methods are hardly acceptible today.

Lewit (17) considers leg length of little interest, "the important question is the inclination of the base of the spinal column, which can be assessed exclusively by x-ray".

There are a few studies comparing clinical and radiological examination of leg length. Clarke (6) found that in only 16 cases out of 50 did two examiners agree within 5 mm from the result of x-ray measurement. Fisk (8) x-rayed those with obvious difference at clinical examination and found that in 30% of cases there was significant difference between the measurements.

As tight muscles can change the rotation of the pelvis, Kendall recommends the assessment to take part in lying (15) and that the result should be confirmed in standing.

Reference points are either the iliac crests (4,6) or the posterior and anterior iliac spines (15). The iliac spines are difficult to detect on x-ray (8) and the level of the iliac crests include some without true LLI (pelvic tilt, anomalies) which can explain part of the weak agreement between the methods. Bailey (1) reports of 88% agreement between low iliac crest and short leg. There is no comparison between Fribergs (9) x-ray method and the clinical evaluation of the level of femoral trochanters.

The consequence of LLI depends on whether it is a structural or functional difference, as well as where the accomodation takes place. Accomodation shows a unique individual pattern. Scoliosis mostly convex to the short leg side, but not always. Pelvic accomodations are unpredictable and can contain both shift and rotation (1,2,3,23).

Wedging of the vertebrae or the disc between them is another consequence, but probably not so early in life (10,14). Giles found in the group with LLI of more than 9 mm, concavities of the end plates of lumbar vertebral bodies, wedging of L5 and traction spurs, which were not seen in the control group. There is no study where the exterior assessment has been correlated to the existence of such x-ray findings. Pelvic tilt and scoliosis for other reasons than LLI can be another reason for the clinical overestimation of LLI reported by Clarke (6).

As the leg length in standing was screened within a prospective study of back pain (12) a further review of the results was carried out.

THE AIMS were to find answers to the following questions:

1. What are the observed frequencies of leg length inequality with this method?
2. How reproducable is the assessment of standing LLI in a screening examination when it is repeated three times by the same person over a period of 3-4 years on about 600 men?

3. How does the observed LLI correlate to other variables in the back examination, and to the level of back pain?

METHOD

The sample. At enlistment for compulsory military training 999 men aged 18-19 years old participated in an extra standardized back examination including assessment of leg length inequality (LLI) in standing. They were seen again at the beginning and end of their military service. The second examination was undertaken 1-3 years after the first one, and the third around 1 year after the second; a total span of 4 years. On each occasion every man answered a questionnaire about, among other things his level of back pain. The answers were not seen by the examiner until after each examination. All these men were healthy and fulfilled their basic military training, but 95% at the start stated some degree of back pain (12).

The assessment. The subject was asked to stand with his feet parallell 10 cm apart, placing equal load on each foot and looking straight ahead. The levels of the anterior and posterior iliac spines were judged by eye during palpation. In uncertain cases even the levels of the femoral trochanters were judged. When the assessment was difficult i.e. in case of obesity, a measuring stand on the floor was used. The result was placed in one of five groups:

1. <0.5 cm difference (equal)
2. 0.5-1.5 cm difference
3. 1.6-2.5 cm difference
4. 2.6-3.5 cm difference
5. Over 3.5 cm difference

A leg was judged higher if both the anterior and posterior spines were at least 0.5 cm higher than on the other side. If an obvious difference in level could be seen but the anterior and posterior spines did not coincide, one higher and one lower, compared to the other side, it was judged as "pelvic rotation", even if the difference was not quite 0.5 cm. The femoral trochanters were in those cases level.

Drop outs.

The second examination was performed completely on 613 subjects and the third on 547. Apart from 262 exempted or not yet drafted (12) the absence was mainly due to difficulties for the subjects of leaving their military training. They were spread all over the country and had to travel to

Stockholm on a certain day for the examination. The drop outs from the second to the third examination showed no significant differences in examination results from the rest, nor did they differ in their degree of pain.

<u>Statistical methods.</u>

Contingency coefficient, c, has been used as a measure of the strength of correlation. Neither the usual correlation coefficient, r, or Spearman´s rank correlation can be used if one of the variables is expressed in a nominal scale. Like the usual correlation coefficients the value of c is zero when there is no correlation, but c never reaches the value 1.0 even if the correlation is perfect. The upper limit for c depends on the number of categories for the studied variables. For 2x2 and 3x3 tables the upper limit value is 0.707 and 0.816 (22). The chi square test has been used to judge if the correlations are statistically significant or not. The level of significance is shown as p (probability), i.e. the probability for a random sample to show at least the observed value, even if there is no correlation.

RESULTS

<u>Frequencies.</u> As can be seen from table 1, around two thirds at each examination were judged to have less than 0.5 cm difference in leg length. Only 3-7% were assessed to have more than 1.5 cm difference.

Table 1

Frequencies of leg length difference at three examinations.
Per cent of total at each examination within brackets.

Examination	<0.5	%	0.6-1.5	%	1.6-2.5	%	2.6-3.5	%	>3.5	% cm
n=999 1.	598	(60)	330	(33)	62	(6)	8	(0.8)	1	(0.1)
n=615 2.	410	(67)	186	(30)	18	(3)	-		1	(0.2)
n=547 3.	355	(65)	174	(32)	18	(3)	-		-	
average		(64)		(32)		(4)				

At all three examinations it was a little more common that the left leg was the shorter one (see table 2). Nine subjects had differences of over 2.5 cm at examination 1. In six of these nine cases however, the right leg was shorter.

Pelvic rotation was fairly common (table 2). It was assessed in 15% of the subjects on average.

Table 2

Frequencies of the different types of leg length difference at the three examinations.
Per cent of total at each examination within brackets.

Examination		Equal	%	Short left leg	%	Short right leg	%	Pelvic rotation	%
n=999	1.	399	(40)	233	(23)	182	(18)	185	(19)
n=615	2.	338	(55)	111	(18)	86	(14)	80	(13)
n=547	3.	287	(52)	98	(18)	83	(15)	80	(14)
average			(49)		(20)		(16)		(15)

Reproducability. Comparisons between results from the three different examinations showed significant correlations (p-values in all cases =0.0001 and a total agreement of 62-66%).

The total agreement between examinations 1 and 3 was 62%. From table 3 can be seen that the changed individual judgements were mainly between the two first classes, and with about the same amount changed in each direction.

The judgement "pelvic rotation" was less consistant than proper LLI. Only 16 out of 97 were assessed similarly from examination 1 to examination 3 (see table 4).

Table 3

Leg length inequality.
Correlation between examinations 1 and 3.
n=547, per cent of total. Total agreement =62%.

EXAMINATION 3					
cm	1.6-2.5	0.2	1	2	
	0.5-1.5	15	14	3	0.2
	<0.5	46	17	1.6	
		<0.5	0.5-1.5	1.6-2.5	2.6-3.5 cm
		EXAMINATION 1			

Table 4

Correlation between different types of leg length difference between examinations 1 and 3. Number of judgements.
n=547, p=0.0001, c=0.529

	EXAMINATION 3				
EXAMINATION 1	Equal	Short left leg	Short right leg	Pelvic rotation	sum
Equal	143	28	17	37	225
Short left leg	54	63	2	5	124
Short right leg	34	1	45	21	101
Pelvic rotation	56	6	19	16	97
sum	287	98	83	79	547

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Correlation to other variables. No correlation could be found between LLI and the judged passive mobility of the lumbar vertebraes L4 or L5, nor was there any correlation to pain tests like the lumbar springing test.
There was a positive correlation (p=0.0001 - 0.0911) within the first and third examinations between LLI and remarks on the mobility of sacro-iliac joints tested in lying. There was no tendency towards more remarks on the SI-joints with bigger difference in leg length. The correlation between LLI and SI-joint mobility did not exist over time, between the examinations. On no occasion was there significant correlation between LLI and subjective back discomfort. Not even over time, from the date of enlistment to the end of basic training, could any positive correlation between back pain and LLI be noted. Those cases stating more back pain at the end of military service than at enlistment did not correlate to any type of LLI. Twelwe people who experienced much more back pain at the end of military service than at the start did not show more LLI at the beginning than the rest. On the other hand, 8 of those 9 persons with a LLI of more than 2.5 cm at enlistment were exempted, for different reasons, not because of back pain. There was a tendency on all occasions towards more problems if the right leg was the shorter one, than in cases where the left leg was the shorter.
None of those with big differences (over 2.5 cm) belonged to the small group of 5% without back pain at enlistment.

DISCUSSION

The common clinical method of assessing LLI has been used in this study. It is therefore of interest to notice that the observed frequencies of LLI are in accordance with those found by some other authors.
Hult (14) found 33% with differences of over 1 cm. The leg length was then measured with a tape in lying. Biering-Sørensen (4) compared the levels of the iliac crests with a pelviruler, and also found 30% of the cases to have a difference of over 1 cm. Friberg with his x-ray method (9) found 43% of LLI over 5 mm. The 15% of pelvic rotation corresponds well with those results Fisk reported (8) where they found 69 (14%) of 500 patients with a pelvic torsion, which disappeared after manipulation.
As can be seen from table 2 a short left leg was more common in this study than short right leg. If only big differences (2.5 cm or more) are taken into account even in this study it is more common with a short right leg. This can be an explanation for the different results reported by other authors.

The tendency in this study towards more back pain if the right leg was the short one than if the left was, is worth nothing. Part of the disagreement about the importance of LLI for back pain could be explained by that difference. Perhaps it is not just the difference as such but also the side that matters as most people have a tendency to take more load on the left leg during standing (19).

Reproducability. A crucial question is of course whether the changed judgements represent a true change or are misjudged. It is not possible to find the answer within this study. A few of these young men were still growing while in military service, and can represent a true change. It could not be shown that changed judgements of LLI correlated to other changes, such as change in mobility, muscle tightness or pain. As the judgement is very sensitive to the mode of standing, a pelvic shift that passes unnoticed can not be excluded. Often the standardized position for the examination was very different from the habitual position and was experienced by the subject as being very awkward. Divergence from the standardized position included both hip rotation, knee flexion or hyper-extension as well as planovalgus foot or lumbar rotation. In a period of increased pain the position is often changed, as noted by Fisk (8). When the leg lengths were rechecked after the patient had become free of symptoms they were often at variance with the original situation.

Those assessed as pelvic rotation at some examination obviously constitute great variation. This group may contain those with unobserved LLI and a compensatory pelvic tilt (1) as well as those with an accomodation in habitual stance because of muscle tightness. The tightness can be more or less permanent.

The correlation between remarks on SI-joint mobility in lying and pelvic rotation in standing at the first examination could either point to a primary cause with locking in the SI-joint or increased rotation as an effect of tension. Both these conditions are probably fairly easily reversible in this young population. The accommodation to LLI is very individual. As described elsewhere (1,2,3), it contains both lumbar lateroflexion and - rotation, tilting of sacrum and pelvic side shift. The accommodations may cause the LLI to pass unnoticed. Friberg (9) has pointed to the varus position of the hip on the longer leg subjecting the articular surface to greater stress, and the following increased incidence of pain and arthrosis in that hip joint. In early stages, as in this study there is not yet arthrosis, but the pain through muscle- and ligament strain is probably experienced as gluteal pain and not easily distinguish-able from back pain. That the LLI did not show an overall positive correlation to back pain is in accordance with other studies (4,11,14). As LLI is only one of several factors that can constitute unfavourable biomechanics in the spine, this is not surprising. LLI could be considered one of several risk factors, but evidently not enough for causing back pain. Some retrospective studies have shown a higher incidence of LLI among back pain patients (9,21) but there is no long term prospective study to compare these findings with.

Exemption from military service during this period was around 12%. It is therefore well over average that out of those 9 with LLI over 2.5 cm, 8 were exempted. Of these 8, one case was due to knee pain, the other for various reasons and in no case because of back pain. Even in normal walk it has been shown that LLI of that degree causes an increased oxygen uptake (7), which leaves the question open if the LLI plays a part in the overall fitness. Consequences of LLI which might be expected over the follow-up period are for instance hypermobile L5, tight hamstring muscles or painful lumbar springing test. No correlations like that could be found. If such changes follow, they apparently take a longer time to appear. The consequencies of LLI of course also depend on the amount of stress imposed on the muscle-joint system. There is always a balance between stress factors and compensatory factors. A follow-up study to this one, when these men are between 30 and 50, might give a chance to get the answers to some questions.

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