THE LUMBAR SPINE IN SPASTIC DIPLEGIA

A RADIOGRAPHIC STUDY

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Some radiological features of the lumbar spine of 84 patients with spastic diplegia were compared with 50 control subjects. The average age of the patients was 20.1 years (3 to 39). Spondylolysis of the fifth lumbar vertebra was found in 21%, four times more frequently than in normal subjects. No patient under nine years of age had spondylolysis and the frequency increased with age. The average angle of lumbar lordosis in spastic patients in the standing position was greater than in normal subjects, and increased with age. The patients had a decreased sacrofemoral angle which caused an increase in Ferguson's angle and explained the increased angle of lumbar lordosis.

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Patients with cerebral palsy, especially those with spastic diplegia, often suffer from low back pain. It restricts their ability to walk and impairs the quality of their lives, but little is known about its causes. We have carried out a radiographic survey of the lumbar spines of spastic diplegic patients to establish their characteristic features.

PATIENTS AND METHODS

We studied 84 patients who had attended any of our three hospitals for the diagnosis and treatment of spastic diplegia. They were all recalled for examination, irrespective of the complaint of low back pain. These patients can therefore be considered to be a random sample of the spastic population. There were 42 males and 42 females; their ages ranged from 3 to 39 years (average 20.1). Six

patients were under 9 years old, 37 between 10 and 19 years, 30 between 20 and 29 years, and 11 were over 30 years. Their previous operations are listed in Table I.

Table I. Relationship between previous surgery and sacrofemoral angle, Ferguson's angle and angle of lumbar lordosis

	Tenotomy or elongation	No operation	p value*
Iliopsoas	7	77	Angle of lumbar lordosis: 0.7402 Ferguson's angle: 0.1939 Sacrofemoral angle: 0.3126
Hamstrings	19	65	Angle of lumbar lordosis: 0.6164 Ferguson's angle: 0.2340 Sacrofemoral angle: 0.8450
Adductors	12	72	Angle of lumbar lordosis: 0.2797 Ferguson's angle: 0.2025 Sacrofemoral angle: 0.5106
Tendo Achillis	22	62	Angle of lumbar lordosis: 0.7141 Ferguson's angle: 0.2218 Sacrofemoral angle: 0.9250

*Student's *t*-test

Most of these had been performed between 5 and 14 years of age (average 9.7). All the patients could walk, either with the help of crutches or unaided. Their occupations included those of white-collar worker, shop assistant, housewife, student, and construction worker.

Fifty people who attended the hospitals for routine physical examinations were used as a control group. After explaining our reasons and gaining their written consent we performed radiography of their lumbar spine. Thirty were male and 20 female; their ages ranged from 13 to 39 years (average 28.5).

The radiographic examination included anteroposterior, lateral, and right and left posterior oblique views of the lumbosacral spine and lateral views in full extension and full flexion to detect dynamic abnormalities. The lateral radiographs were taken with the patient standing, to measure the angle of lumbar lordosis, Ferguson's angle (Ferguson 1934; Hellems and Keats 1971) and the sacrofemoral angle (Bleck 1971; Fig. 1). Mild sedatives were sometimes needed to help the patients to stand still. The lateral radiographs were obtained with the hip and knee in full extension so that the position resembled that in the most lordotic phase of walking. The patients stood bare-footed, holding a bar in front of them, and looking

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Fig. 1

Fig. 2

Figure 1 – The angle of lumbar lordosis is that between the upper borders of the first sacral and the first lumbar vertebral bodies. Ferguson's angle is that between the upper border of the first sacral body and a horizontal line. The sacrofemoral angle is that between the upper border of the first sacral body and the long axis of the femur. Figure 2 – A patient positioned for radiography.

forward at a point at eye level (Fig. 2). One radiograph, focused on the third lumbar vertebra, provided an overview of the lumbar spine, from the first lumbar vertebra to the sacrum. This was used to measure the angle of lumbar lordosis. A second radiograph showed the region from the fifth lumbar vertebra to the proximal third of the femur, and was used to measure Ferguson's angle and the sacrofemoral angle.

The relationships between the sacrofemoral and Ferguson's angles, between Ferguson's angle and the angle of lumbar lordosis, and between the sacrofemoral angle and the angle of lumbar lordosis were analysed statistically and the effect of previous operations on these angles was evaluated.

Spondylolisthesis was defined as slip exceeding 5%, measured by the method of Taillard (1954). Patients were diagnosed as suffering from low back pain if it affected the activities of daily living or diminished their walking ability.

RESULTS

Spondylolysis. Spondylolysis was found in 18 patients, always in the fifth lumbar vertebra. Six were between 10 and 19 years old, eight were between 20 and 29 years, and four were over 30 years of age. None under nine years of age had spondylolysis. The lesion was bilateral in ten patients and unilateral in eight. In the patients under 19 years of age, all the lesions were unilateral. In those over 20 years of age, the spondylolysis was bilateral in 83%. Three spondylolytic lesions were found in the

control group (6%). The incidence of spondylolysis has been reported to be between 1.1% and 6.4% in the normal population (Roche and Rowe 1952; Baker and McHollick 1956; Eisenstein 1978; Fredrickson et al 1984).

Spondylolysis was found in 29.4% of patients with a lumbar lordosis of 50° or more and in 7.2% of those with a lordosis of less than 50°. The larger the angle of lumbar lordosis, the greater was the chance of spondylolysis.

Spondylolisthesis. Spondylolisthesis was found in three diplegic patients (4%), one male and two females. They were 20, 21 and 34 years old. The spondylolisthesis measured 3 mm, 4 mm and 3 mm and the angle of lumbar lordosis was 77°, 59° and 59° respectively. All suffered from low back pain.

Lumbar lordosis. The average angle of lumbar lordosis was 53.6°, and it increased with age (Fig. 3).

Ferguson's angle. The average Ferguson's angle was 39.7° and it increased with age (Fig. 4).

Sacrofemoral angle. The sacrofemoral angle averaged 35.6° in the diplegic group and 52.7° in the control group (Fig. 5).

Previous operations had no significant effect on these three angles (Table I).

In the control group, the mean values of the angle of lumbar lordosis, Ferguson's angle and the sacrofemoral angle were 45.0°, 32.1° and 52.7° respectively, and none was age-dependent.

In the patients with spastic diplegia, there was a clear correlation between the angle of lumbar lordosis, Ferguson's angle and the sacrofemoral angle (Fig. 6).

Low back pain. Low back pain was present in 44% of the

Fig. 3

The average angle of lumbar lordosis was 53.6° in the patients with spastic diplegia and it increased with age ($r = 0.345$). In the control group, the average angle was 45.0° and it did not increase with age.

Fig. 4

The average Ferguson's angle was 39.7° in the patients with spastic diplegia and it increased with age ($r = 0.429$). In the control group, the average Ferguson's angle was 32.1° and it did not increase with age.

Fig. 5

The average sacrofemoral angle was 35.6° in the diplegics and showed a tendency to decrease with age ($r = 0.308$). In the control group, the average angle was 52.7° and it did not alter with age.

Fig. 6a

Fig. 6b

Fig. 6c

In the spastic patients all three measured angles correlated. Figure 6a – Ferguson's angle decreased with increase in the sacrofemoral angle ($r = 0.797$). Figure 6b – The angle of lumbar lordosis and Ferguson's angle increased proportionally ($r = 0.623$). Figure 6c – The angle of lumbar lordosis increased with decrease in the sacrofemoral angle ($r = 0.442$).

spastic diplegic patients. It was found in none of the patients under 9 years old, in 38% of those aged 10 to 19, in 53% of those aged 20 to 29, and in 64% of those over 30 years of age. Patients with lordosis of more than 70° frequently had low back pain (75%) while those with lordosis of less than 50° seldom complained of low back pain (39%). It was present in 55% of the patients with spondylolysis and in 41% of those without.

Osteoarthritis. Osteoarthritis of the L5/S1 facet joints, assessed by the method of Kellgren and Lawrence (1958), was found in 67% of the diplegic patients aged 20 years or more. Disc degeneration was less frequently seen.

DISCUSSION

The patients with spastic diplegia had a higher incidence of spondylolysis and a greater average angle of lumbar lordosis than did the control group. Increased lordosis causes proportionally greater compressive and shearing forces in the posterior elements of the spine (Nachemson 1960; King, Prasad and Ewing 1975; Yang and King 1984; Ogilvie and Sherman 1987). The pars interarticularis is subject to higher mechanical stresses than other parts of the posterior elements (Dietrich and Kurowski 1985) and is therefore liable to fatigue fracture from the compression forces applied in the standing position (Wiltse, Widell and Jackson 1975; Cyron and Hutton 1978). The increased compression force in the lordotic spine, applied at the site of repeated flexion/extension movements during walking, renders patients with spastic diplegia susceptible to spondylolysis (Rosenberg, Bargar and Friedman 1981). It was found only in the fifth lumbar vertebra. This vertebra, placed between the movable lumbar spine and the immovable sacrum, is situated like a cantilever, the lowest part of which bears the brunt of the increased compression force.

The mean average sacrofemoral angle in the patients was diminished, because of the flexion contractures of their hips, while their average Ferguson's angle was greater than normal because of the increased lordosis. The decreased sacrofemoral angle may be an expression of the spasticity in the hip flexors and the spasticity of the lumbar muscles contributes to the increased lumbar lordosis.

Nearly half the patients with spastic diplegia complained of low back pain. Its frequency was directly

proportional to age and to the degree of lumbar lordosis. It was, however, independent of the presence or absence of spondylolysis. These observations suggest that any procedure which reduces the lumbar lordosis in a spastic diplegic patient without adversely affecting postural balance would have a beneficial effect on low back pain.

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