Increased external tibial torsion in Osgood-Schlatter disease

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ABSTRACT **We studied the relationship between Osgood-Schlatter disease and torsional abnormalities of the lower limb in 21 boys with this condition and 20 age- and sex-matched controls. 3 groups of knees (20 control knees, 21 symptomatic and 21 asymptomatic or less symptomatic knees) were subjected to clinical, radiographic and CT evaluation. We found no statistically significant differences between patients and controls, as regards femoral anteversion, patellar congruence angle, patellar tilt angle and anterior tibial tuberosity-trochlear groove distance, but the condylomalleolar angle and tibial torsion angle were greater in patients. We found no differences between symptomatic and asymptomatic or less symptomatic knees in any of the parameters. All the symptomatic knees were on the side preferentially involved in jumping and sprinting. This increase in external tibial torsion may play a role as a predisposing mechanical factor in the onset of Osgood-Schlatter disease in male athletes.**

Several etiologies have been suggested for Osgood-Schlatter disease, including trauma, local alterations of the chondral tissue (Ehrenborg and Engfeldt 1961), mechanical overpull by the extensor muscles of the knee, which can result in patella alta and traction apophysitis (Jakob et al. 1981, Aparicio et al. 1997), eccentric muscle pull and muscle tightness (Ikeda et al. 1996), and reduced width of the patellar angle (Sen et al. 1989).

The relation between torsional alignment of the lower limb and some disorders of the knee, such as arthrosis, patellofemoral instability and patellar chondromalacia, has been firmly established (Fairbank et al. 1984, Eckhoff et al. 1994, Fabry et al. 1994, Turner 1994, Yagi 1994).

We evaluated the possible association between Osgood-Schlatter disease and lower limb torsional abnormalities.

Patients and methods

Patients

In a 1-year epidemiologic study of orthopedic diseases affecting adolescents practicing basketball or volleyball, we diagnosed and treated Osgood-Schlatter disease in 21 boys. Their median age was 14 (12–16) years; weight 55 (43–67) kg, height 166 (151–174) cm and they all came from the same geographic region (Marche, Italy). 14 patients had unilateral symptoms; in the 7 boys with bilateral involvement one knee always had more symptoms than the other. 14 were basketball players and 7 volleyball players, all of whom had similar training programs in terms of duration, intensity and number of sessions. The patients underwent clinical, radiographic and CT evaluation.

Control group

20 adolescent males (median age 14 (13–16) years, weight 51 (45–68) kg, height 163 (154–178) cm) admitted to our CT service for conditions that did not involve the lower limbs served as controls. The inclusion criteria were: basketball or volleyball players, same region of origin as our patients, absence of endocrinologic, metabolic or growth disorders and way of life similar to that of our patients. After obtaining their and their parents' informed

CT parameters in Osgood-Schlatter patients and control subjects. Mean (SD)

	Controls (20 knees)	P (unpaired t-test)	Symptomatic (21 knees)	P (paired t-test)	Asymptomatic and less symptomatic (21 knees)
Femoral anteversion	11 (9)°	0.9	12 (6)°	0.9	12 (5)°
Congruence angle	10 (26)°	0.6	6 (15)°	0.5	3 (14)°
Patellar tilt angle	17 (8)°	0.1	21 (8)°	0.8	20 (6)°
TT–TG distance (mm)	12 (5)	0.1	14 (4)	0.5	13 (4)
Condylomalleolar angle	31 (9)°	<0.001	47 (11)°	0.2	40 (7)°
Tibial torsion angle	12 (8)°	<0.001	28 (8)°	0.5	26 (10)°

TT–TG distance anterior tibial tuberosity–trochlear groove distance

consent, 6 CT sections of the right or the left knee were taken, as selected by a random number-generating program. None of the control subjects had signs or symptoms suggestive of Osgood-Schlatter disease for 2 years after the study.

CT examination

3 groups of knees were examined: 20 control knees, 21 symptomatic and 21 asymptomatic or less symptomatic knees. In patients, CT was performed a median 3 (2–4) months after developing symptoms; training was suspended, but therapy was not given before CT.

Subjects were placed in the supine position, with hips and knees fully extended and thighs and legs horizontal and parallel, as described by Reikerås and Høiseth (1989). Tomograms of both lower limbs were taken with a General Electric CT Pace instrument (3 sec scanning time, 512 × 512 reconstruction matrix, 2 mm slice thickness, 125 kV, 390 mAs). The topogram-scan technique was used to find the best CT sections (Figure 1). Each CT examination required 6–9 sections. To avoid measurement errors, patients were positioned so that the plane of the femoral condyle was perpendicular to the section plane.

CT sections were taken: A) at the center of the femoral head; B) at the base of the femoral neck; C) in the central midtrochlear region of the femoral condyle, identified by the Roman arch appearance of the intercondylar groove with the apex of the Roman arch corresponding to 1/3 of the height of the condyle; D) at the proximal tibial epiphyseal level, which lies midway between the tibial plateau and the upper end of the proximal tibio-fibular joint (Eckhoff and Johnson 1994); E) at the proximal end of the anterior tibial tuberosity, and F) at the upper end of the distal tibio-fibular joint (Figure 1).

The tomograms thus obtained were analyzed by measuring: 1) femoral anteversion on superimposed sections A, B and C, using Murphy et al.'s method (1987); 2) the patellar congruence angle and 3) the patellar tilt angle, on section C, as described by Eckhoff and Johnson (1994) and by some of us in a previous study (Guzzanti et al. 1994); 4) the condylomalleolar angle, on superimposed sections C and F (Beaconsfield et al. 1994); 5) the distance (in mm) between the anterior tibial tuberosity and the trochlear groove (TT-TG), on superimposed sections C and E (Beaconsfield et al. 1994); and 6) the external tibial torsion angle, on superimposed sections D and F (Beaconsfield et al. 1994) (Figure 2).

To increase reproducibility as regards goniometric manual measurements, all measurements were made by the CT computer directly on the superimposed images. Data were expressed as means (SD). As values had a normal distribution, the statistical analysis was done with ANOVA and the Student's t-test on paired and unpaired data.

Results

We found no statistically significant differences between the means of patients and controls in femoral anteversion, patellar congruence angle, patellar tilt angle and TT-TG distance. The mean condylomalleolar and mean tibial torsion angles were higher in patients (< 0.001) than in controls. We found no differences between symptomatic and asymptomatic or less symptomatic knees in any of the parameters (Table).

Figure 1. Scout views (left) were used to find the following CT sections: A) the center of the femoral head; B) the center of the base of the femoral neck; C) the central midtrochlear region recognized by the Roman arch appearance of the intercondylar groove; D) the proximal tibial epiphyseal level; E) the upper end of the anterior tibial tuberosity; and F) the upper end of the distal tibio-fibular joint.

All the symptomatic knees in patients with unilateral disease and the more symptomatic knees in bilateral disease were on the side preferentially involved in jumping and sprinting.

Discussion

Several authors have shown the effects of changes in the torsional alignment of the leg on the genesis of many disorders of the knee (Eckhoff et al. 1994,

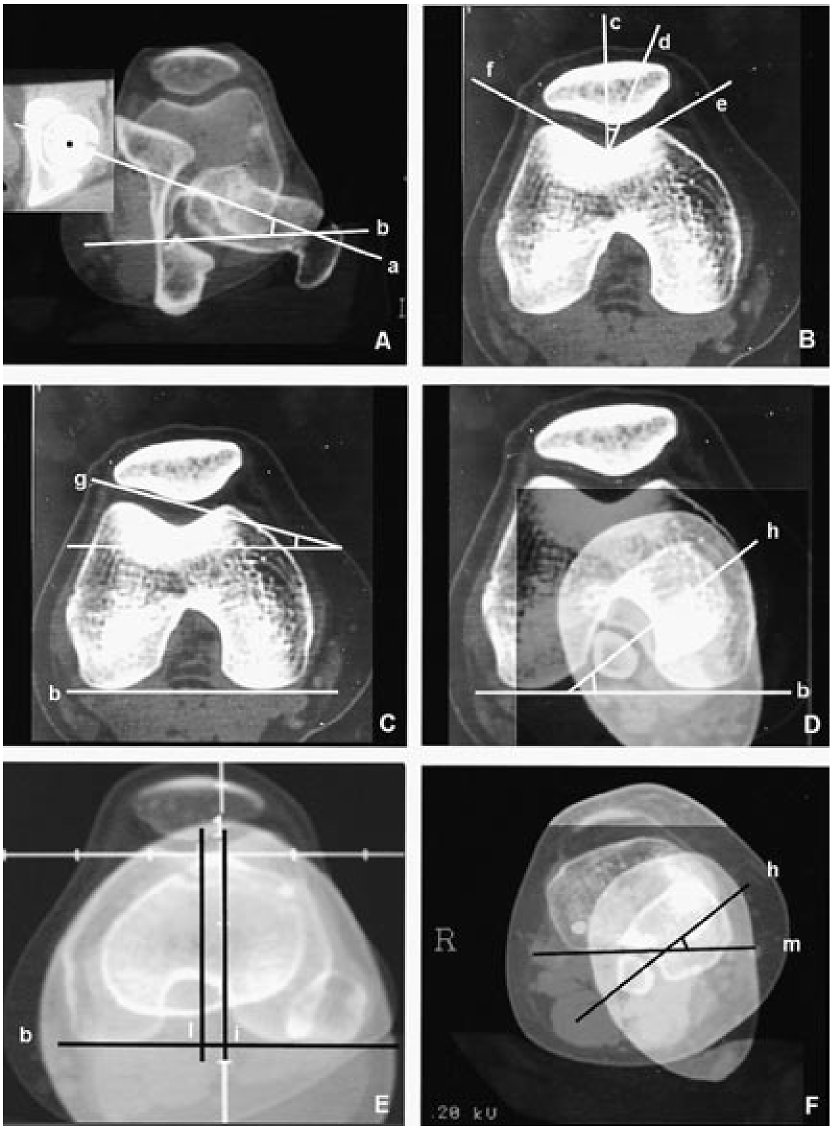

Figure 2.

A. Femoral anteversion is measured on superimposed sections A, B, C of the CT scan. It is defined by the intersection of a line passing through the femoral neck and the center of the femoral head (a) and a line drawn through the posterior border of the femoral condyles (b).

B. The patellar congruence angle is measured on section C of the CT scan and lies between the bisector (c) of the sulcus angle and a line drawn between the deepest point of the trochlea and the edge of the patellar crest (d). The sulcus angle is identified by two lines drawn from the deepest point of the trochlea, one passing across the edge of the medial condyle (e) and the other across the edge of the lateral condyle (f).

C. The patellar tilt angle is identified on section C of the CT scan by the intersection of a line drawn through the posterior border of the femoral condyle (b) and a line parallel to the lateral facet of the patella (g).

D. The condylomalleolar angle is obtained by overlapping sections C and F of the CT scan. It lies between a line drawn through the posterior border of the femoral condyle (b) and a line passing through the tibio-fibular joint (h).

E. The TT-TG distance is measured on superimposed sections C and D. It results from the distance (in mm) between two lines perpendicular to the posterior border of the femoral condyle (b), one from the tibial tuberosity (i) and the other from the trochlear groove (l).

F. The tibial torsion angle is measured by overlapping the sections D and F of the CT scan. This is defined by the intersection of a line passing through the posterior border of the tibial epiphysis (m) and one passing through the tibio-fibular joint (h).

Lee et al. 1994, Muneta et al. 1994, Yagi 1994). In particular, Turner (1994) found that internal tibial rotation may predispose to medial gonarthrosis. Using an arthrometric method, the same researchers observed that patients with Osgood-Schlatter disease have increased external tibial rotation, but they did not discuss these findings. Recently, Lampert and co-workers (2000) did a clinical and CT study of tibial torsion, but focused on the surgical treatment of the defects.

Our CT study, using a method that Eckhoff and Johnson (1994) consider the most accurate for measuring lower limb rotation, showeda close relation between Osgood-Schlatter disease and increase in external tibial torsion.

Such an association does not imply a cause and effect relationship. However, it is conceivable that this torsional abnormality, probably in conjunction with other factors, may be a mechanical factor that predispose to the onset of Osgood-Schlatter disease in male athletes.

Given the load-bearing mechanism of the knee, changes in the external tibial torsion angle could affect the distribution of stress around the knee (Burstein and Wright 1993). In particular, the wider the external tibial torsion angle, the greater the shear stress (lateral-medial force) on the tibial tuberosity, especially during extension of the knee, when automatic external tibial rotation causes an increase in shear stress. However, more research is needed to gain greater insight into this mechanism.

Our data suggest that the increase in the shear component of the force exerted on the tibial tuberosity, especially when running or jumping, may affect the metabolism of the growth plate of the tibial apophysis, and predispose to Osgood-Schlatter disease.

We found no significant differences between symptomatic and asymptomatic or less symptomatic knees in any of the torsional parameters analyzed, but a close relationship between the side preferentially involved in jumping and sprinting and the more symptomatic side. The total stress on the symptomatic knee should exceed the stress on the contralateral side. Therefore, although external tibial rotation is the same in both knees, the shear stress should be greater on the affected side, and play a significant pathogenetic role in Osgood-Schlatter disease.

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Aparicio G, Abril J C, Calvo E, Alvarez L. Radiologic study of patellar height in Osgood-Schlatter disease. J Pediatr Orthop 1997; 17: 63-6.

Beaconsfield T, Pintore E, Maffulli N, Petri G. Radiological measurements in patellofemoral disorders. Clin Orthop 1994; 308: 18-28.

Burstein A H, Wright T M. Biomechanics. In: Surgery of the knee (Ed. Insall J N). Churchill Livingstone Inc., New York 1993; 3: 43-62.

Eckhoff D G, Johnson K K. Three-dimensional computed tomography reconstruction of tibial torsion. Clin Orthop 1994; 302: 42-6.

Eckhoff D G, Montgomery W K, Kilcoyne R F, Stamm E R. Femoral morphometry and anterior knee pain. Clin Orthop 1994; 302: 64-8.

Ehrenborg G, Engfeldt B. Histologic changes in the Osgood-Schlatter lesion. Acta Chir Scand 1961; 121: 328-36.

Fabry G, Cheng L X, Molenaers G. Normal and abnormal torsional development in children. Clin Orthop 1994; 302: 22-6.

Fairbank J C T, Pynsent P B, van Poortvliet J A, Phillips H. Mechanical factors in the incidence of knee pain in adolescents and young adults. J Bone Joint Surg (Br) 1984; 66 (5): 685-93.

Guzzanti V, Gigante A, Di Lazzaro A, Fabbriciani C. Patellofemoral malalignment in adolescents. Computerized tomographic assessment with or without quadriceps contraction. Am J Sports Med 1994; 22 (1): 55-60.

Ikeda H, Yamauchi Y, Sakuraba K, Kim S. Etiologic factor of Osgood-Schlatter disease in young sports players. In: Proceedings of the 20th Congress of the SICOT, Amsterdam, The Netherlands, 1996: 663 (P2.460).

Jakob R P, von Gumppenberg S, Engelhardt P. Does Osgood-Schlatter disease influence the position of the patella? J Bone Joint Sur (Br) 1981; 63 (4): 579-82.

Lampert C, Thomann B, Brunner R. Tibiale torsionsfehler. Orthopäde 2000; 29: 802-7.

Lee T Q, Anzel S H, Bennet K A, Pang D, Kim W C. The influence of fixed rotational deformities of the femur on the patellofemoral contact pressures in human cadaver knees. Clin Orthop 1994; 302: 69-74.

Muneta T, Yamamoto H, Ishibashi T, Asahina S, Furuya K. Computerized tomographic analysis of tibial tubercle position in the painful female patellofemoral joint. Am J Sports Med 1994; 22 (1): 67-71.

Murphy S B, Simon S R, Kijewski P K, Wilkinson R H, Griscom T N. Femoral anteversion. J Bone Joint Surg (Am) 1987; 69 (8): 1169-76.

Reikerås O, Høiseth A. Torsion of the leg determined by computed tomography. Acta Orthop Scand 1989; 60 (3): 330-3.

Sen R K, Sharma L R, Thakur S R, Lakhanpal V P. Patellar angle in Osgood-Schlatter disease. Acta Orthop Scand 1989; 60 (1): 26-7.

Turner M S. The association between tibial torsion and knee joint pathology. Clin Orthop 1994; 302: 47-51.

Yagi T. Tibial torsion in patients with medial-type osteoarthrotic knees. Clin Orthop 1994; 302: 52-6.