



Hip rotation degrees, intoeing problem, and sitting habits in nursery school children: an analysis of 1134 cases

Anaokulu çocuklarında kalça rotasyon dereceleri, içe dönük yürüme sorunu ve oturma alışkanlıkları: 1134 olgunun analizi

Levent ALTINEL, Kamil CAGRI KOSE, Yusuf AKSOY, Cengiz ISIK, Volkan ERĞAN, Aykut OZDEMİR

Afyonkarahisar Kocatepe University Faculty of Medicine, Department of Orthopedics and Traumatology

Amaç: Bu çalışmada anaokulu çocuklarının kalça rotasyon dereceleri, içe dönük yürüme (intoeing) sorunları ve oturma alışkanlıkları ve bu ölçümler arasındaki ilişki araştırıldı.

Çalışma planı: İlimiz merkezinde bulunan 26 anaokulundaki 3-6 yaş arasında 1134 çocuk (612 erkek, 522 kız) çalışmaya alındı. Çalışma için önce ebeveynlerden muayeneler için izin formu ile çocuğun demografik verileri ve oturma alışkanlığını sorgulayan bir form toplandı. Daha sonra anaokullarındaki çocuklar çıplak olarak muayene edildi. Ayak progresyon açılarına bakılarak orta hatta yönelimler içe dönük yürüme olarak değerlendirildi. Sırtüstü ve yüzüstü pozisyonunda kalça iç ve dış rotasyon dereceleri gonyometre ile ölçüldü.

Sonuçlar: Kızlarda kalça iç rotasyon dereceleri erkeklerden yüzüstü pozisyonunda yaklaşık 13 derece, sırtüstü pozisyonunda 9 derece daha fazla bulundu. Altmış yedi çocukta (%5.9) içe dönük yürüme saptandı. Bu olguların %76.1'inde sorun iki taraflıydı. Kız-erkek oranı 2.4/1 bulundu. İçe dönük yürüme sorununun %74.6'sı femoral, %25.4'ü tibial kaynaklıydı. Bu sorunu olanlarda kalça iç rotasyon dereceleri normal çocuklardan daha fazla, dış rotasyon dereceleri ise daha az idi. Çocukların %36.7'si bağdaş kurarak oturma, %63.3'ü televizyon oturuşu alışkanlığına sahipti. İçe dönük yürüme sorunu olan çocuklarda televizyon oturuşu alışkanlığı daha yüksekti ($p=0.001$).

Çıkarımlar: Çalışmamızda, kalça rotasyon açıklıkları literatürde bildirilen değerlerle benzerlik göstermiş, kalça iç rotasyon dereceleri ise, özellikle kızlarda olmak üzere daha yüksek bulunmuştur. Anaokulu çocuklarında yaygın tercih edilen oturma şekli olan televizyon oturuşu, içe dönük yürüyen çocuklarda daha yüksek oranda görülmektedir.

Anahtar sözcükler: Kemik hastalığı, gelişimsel/patoloji; çocuk, okul öncesi; ayak/fizyopatoloji; yürüyüş/fizyoloji; kalça eklemi.

Objectives: We investigated hip rotation degrees, frequency of intoeing problems, and sitting habits in nursery school children and the relationship between these parameters.

Methods: The study included 1,134 children (612 boys, 522 girls), aged between three to six years, attending 26 nursery schools in the central area of Afyon. First, informed consent was obtained from the parents and a questionnaire was administered about demographic data and sitting habits of the children. Then, the children were examined in lower underwear. Foot progression angles were determined and progression to midline during walking was evaluated as intoeing. Internal and external rotation degrees of the hips were measured using a goniometer in prone and supine positions.

Results: In girls, internal rotation of the hip was nearly 13 degrees greater in the prone position, and 9 degrees greater in the supine position compared to those of the boys. Intoeing was detected in 67 children (5.9%), 76.1% being bilateral. The girl-to-boy ratio was 2.4/1. Intoeing problem originated from the femur in 74.6%, and from the tibia in 25.4%. Compared to normal children, intoeing was associated with a greater internal rotation and a smaller external rotation of the hip. Overall, 36.7% had a crossed-leg sitting habit, and 63.3% had a television sitting habit. The latter was more frequent in intoeing children ($p=0.001$).

Conclusion: Although hip rotation degrees in our study were similar to those reported in the literature, higher hip internal rotation degrees were found especially in girls. Television sitting which is a frequently preferred position among nursery school children was significantly prevalent in intoeing children.

Key words: Bone diseases, developmental/pathology; child, preschool; foot/physiopathology; gait/physiology; hip joint.

Intoeing is one of the most common pediatric gait disturbances. Such abnormality is usually noticed by the parents and the close environment. The clinical presentation is physiological in many children, and 90-95% correct on their own without any need for active treatment.^[1] However, intoeing is still one of the most common complaints accounting for visits to orthopedists or pediatricians during the infancy.

Intoeing is associated with internal femoral torsion in 70%, and with internal tibial torsion in 30% of cases.^[2] Femoral anteversion (medial femoral torsion) is usually apparent between 3 to 6 years of age during the pre-school period, and gradually corrects up to 8 to 9 years of age.^[3,4] Involvement is often bilateral and symmetrical, and more common in females. It has a familial character.^[4] Children with intoeing prefer to sit in the so called television position (W position). They can not sit cross-legged or they feel disturbed. The functional disturbance is resolved by the compensation resulting from spontaneous correction in the medial femoral torsion or from increased external rotation of the tibia. External rotation restriction may occur in uncorrected advanced deformities between 8 and 10 years of age (hip can be externally rotated only up to 0-10 degrees).^[5]

The objective of the present study was to determine the hip rotation degrees, the frequency of intoeing problems and sitting habits in 1134 preschool children and to reveal their relationship with the hip rotations.

Patients and method

A total of 26 nursery school present in our provincial center was included in the study. An approval was obtained from the state's health and education departments, and the human ethical board of our university. A couple of days before the orthopedic examination, a form of consent was sent to the parents accompanied with a questionnaire about the sitting habits of the children. The responses were collected from the class teachers during the visits to the schools. The visits were paid by two investigators under the supervision of an expert. The chairs were arranged to compose a 1 m wide and 5 m long walkway in the game room. A line was drawn with a ribbon right in the middle of the walkway on the carpet. The children were taken into the room in groups of 10 accompanied by their teacher, and all

were undressed and left only in their underclothes. They were made to walk on the line at least twice through the walkway. Thus, the foot progression angle to the mid-line was determined for each foot. And, each gait where the tips of foot were curved to the midline was considered intoeing.^[4] The orthopedic examination was performed on the gymnastic mattresses. The torsional profile was examined only in children with intoeing problem in order to determine the underlying cause. And, then the pelvis of the child, who was laid back into a supine position, was fixed to the ground with the help of an assistant. The hip and knee being flexed to 90 degrees, the angle of the tibia to the vertical axis was measured by goniometer and recorded obtaining the maximum internal and external rotation values for each hip. And, then the child was turned into the prone position to measure and record the amount of internal rotation simultaneously on both sides and the amount of external rotation separately, with the hip extended and the knee flexed to 90 degrees. The normal limits were set to ± 2 standard deviation of the measurements, any value above it being considered torsional deformity (Staheli).

The SPSS 11.5 program was used for the statistical analyses. For comparison of age groups, ANOVA test, and for all other parameters, Student's t-test were used whereas chi-square test was employed for non-parametric data. A p-value of <0.005 was considered significant, showing the standard deviations.

Results

Out of a total of 1134 children, 612 were boys (54.0%), and 522 were girls (46.0%). The distribution of age is shown in Figure 1. The mean rotation degrees and standard deviations, minimum and maximum values and upper and lower limits determined

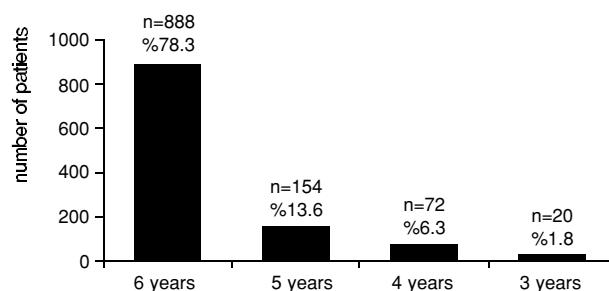


Figure 1. Distribution of age

Table 1. Normal hip rotation degrees

Hip rotations	Minimum	Maximum	Mean.±SD	Normal range (±2 SD)
SER (°)	22.5	105.0	76.5±11.2	54-99
SIR (°)	20.0	105.0	64.1±18.7	27-102
PER (°)	10.0	90.0	41.2±12.0	17-65
PIR (°)	12.5	95.0	64.3±16.2	32-97

S: supine position, P: prone position, ER: external rotation, IR: internal rotation, SD:Standard deviation

during the hip examinations are shown in Table 1. No significant difference was found between the age groups in the hip rotation degrees ($p>0.005$). When the change of hip rotations was analysed by gender, it was found that the internal rotation values were greater in girls than in boys both in the supine and prone positions (Table 1). Based on this, the mean hip internal rotation was greater in girls by 13 degrees in prone position, and by 9 degrees in supine position compared to the boys.

Sixtyseven children (%5.9) had intoeing problem following the examination in the walkway. The involvement was on the left side in 7 (10.5%), and on the right side in 9 (%13.4) children, and it was bilateral in 51 (76.1%) children. The girl to boy ratio was 2.4/1. The intoeing problem originated from the increased femoral anteversion in 74.6%, and from tibial internal rotation in 25.4%. The hip rotation degrees of the children with intoeing problem were compared with the hip rotations of normal children (Table 3). Based on this comparison, it was found that the internal rotation degrees of the children with intoeing problem measured both in supine and prone positions were greater than of the normal children while the external rotation degrees were smaller.

The question regarding the sitting habits of the children was answered by their parents. According

to this, 36.6% of them sat cross-legged while 63.4% had acquired habit of television position. The habitual television position was significantly higher in intoeing children compared to the cross-legged position ($p=0,001$) (Table 4). However, the gender had no impact on the sitting habits ($p=0.342$).

Discussion

As the selected study sites were the nursery schools located in our provincial center, the main age group consisted of 6 year-old children (78.3%). The preschool period includes the group of children between 4-7 years of age, during which the toeing is clinically seen most frequently.^[6] Yorgancigil et al. studied the torsional deformities of the lower extremity in 21.499 primary school students with an age range from 6 to 12 years.^[7] In this study, the prevalency of intoeing for children \leq 6 years old was 8.1% and, most of the cases were bilateral. The girl to boy ratio was again 2.1/1. As a result of analyses on all age groups, they found that the problem of intoeing originated from femoral anteversion in 76%, tibial internal rotation in 12%, developmental genu varum in 9%, and metatarsus varus in 3% of cases. In parallel to these studies, we obtained a prevalence rate of 5.9% for intoeing and a girl to boy ratio of 2.4/1. The involvement was bilateral in 76% of our intoeing cases. Similarly, the intoeing origi-

Table 2. Hip rotation degrees by sex

Hip rotations	Sex	Mean.±SD	Normal range (±2 SD)	<i>p</i>
SER (°)	Male	76.1±11.4	53-99	0.330
	Female	77.0±10.5	56-98	
SIR (°)	Male	60.4±18.6	23-98	0.0001
	Female	69.7±16.4	37-103	
PER (°)	Male	42.0±11.6	19-65	0.552
	Female	42.5±12.4	18-67	
PIR (°)	Male	57.9±15.4	27-89	0.0001
	Female	70.9±14.5	42-100	

S: supine position, P: prone position, ER: external rotation, IR: internal rotation,SD:Standard deviation

Table 3. Hip rotation degrees in intoeing

Hip rotations	Gait	Mean.±SD	<i>P</i> value
SER (°)	Normal	76.7±11.1	0.032
	Intoeing	72.6±12.5	
SIR (°)	Normal	63.9±18.7	0.035
	Intoeing	68.1±17.8	
PER (°)	Normal	41.3±11.8	0.031
	Intoeing	38.5±16.1	
PIR (°)	Normal	96.0±24.1	0.001
	Intoeing	106.1±27.4	

S: supine position, P: prone position, ER: external rotation, IR: internal rotation, SD:Standard deviation

nated from femur in 74.6%, and tibia in 25.4% of cases. The involvement is often bilateral in intoeing, and spasticity, developmental hip dysplasia or Perthes's disease should be considered in case of asymmetrical involvement.^{16,81}

In a study on rotational problems of the lower extremities, Staheli evaluated the 1000 lower extremities of 500 normal children and adults (279 females, 221 males) between 1 – 70 years of age by means of physical examination and photographic method. During the hip rotation measurements in the prone position, she found that the internal rotation was greater by 7 degrees in females than in males. Based on this result, the mean hip internal rotation was 50 degrees in males, and 40 degrees in females. And the normal limits were within 15–60 degrees in females, and 25–65 degrees in males. The mean external rotation was 45 degrees, ranging from 25 to 65 degrees.¹⁴ In the present study, in the prone position, the mean internal rotation was 70.9 (42–100), and the external rotation was 42.5 (18–67) in females whereas they were 57.9 (27–89), and 42.0 (19–65) in males, respectively. Although the hip rotation measurements are usually performed in the prone position, Gelberman et al. reported that the hip

capsule and soft tissues are loosened during flexion, allowing more external rotation so that femoral anteversion can be evaluated better.⁹¹ In the present study, the mean external rotation was 76.5 degrees in the spine position, and 41.2 degrees in the prone position. During the measurements in supine position, the mean value for internal rotation was 69.7, and 77.0 for external rotation in females, and 60.4 and 76.1 in males, respectively. Based on this measurement, the hip internal rotation was greater in females by 13 degrees in average in the prone position, and by 9.3 degrees in the supine position compared to males. When our results are compared with the normal limits of the hip rotation described by Staheli, our internal rotation values were found higher with a tendency to be displayed by females more, but the external rotation values were similar.

Although sitting habits are effective in the development of the anatomical structure¹⁰⁰, on the contrary, torsional deformities may have an impact on the sitting position during the childhood.¹⁶ As a result of increased hip internal rotation and reduced external rotation associated with increased femoral anteversion, the child cannot sit cross-legged, and feels comfortable at W position.^{11,111} The 70% of

Table 4. Relationship of sitting habits with sex and intoeing

	Sitting Habits				<i>P</i> value
	Cross-legged		W Position		
	No	%	No	%	
Sex					
Male (n=612)	238	38.9	374	61.1	0.342
Female (n=522)	178	34.1	344	65.9	
Intoeing (n=67)	13	19.4	54	80.6	0.001

intoeing is associated with the femoral anteversion, and 30% with excessive tibial internal rotation.^[2] The mean femoral antetorsion is 40 degrees at birth, and it gradually decreases by age, even to 15 degrees during adolescence.^[12,13] In the present study, there was an increase in the hip internal rotation of the intoeing children, and a decrease in the external rotation, which has been also emphasized at the study by Staheli, and as the femoral anteversion increased, the hip internal rotation was increased and external rotation was decreased.^[4] Consequently, this statistically significant results we obtained in our intoeing subjects indirectly indicated that excessive femoral anteversion determined in the majority of our intoeing subjects leads to problems. The habitual television position was observed in 63.4% of the children. However, the rate of intoeing was 5.9% during the examination, and the television position was more common in the toeing children. When it is considered that 63.4% of cases preferred television position, but only 5.9% had intoeing gait, it suggests that many of the torsional deformities are not usually so severe to be reflected to the clinic. Staheli indicated that the internal rotation was greater by 7 degrees in females than in males, and similarly in our series we found that females had a greater internal rotation both in supine and prone positions. In spite of these results, no difference was found between genders in the sitting habits. In this case, we believe that it is hard to conclude that the sitting habits developed depending only on the torsional deformities.

In conclusion, we found higher hip internal rotation degrees, particularly in females compared to the

literature although the range of hip internal rotation we obtained is similar to the ones in literature. The television position is a quite common way of sitting among the preschool children, particularly with a high prevalence in toeing children.

References

1. Staheli LT. Rotational problems of the lower extremities. *Orthop Clin North Am* 1987;18:503-12.
2. Fabry G, Cheng LX, Molenaers G. Normal and abnormal torsional development in children. *Clin Orthop Relat Res* 1994;(302):22-6.
3. Staheli LT. Medial femoral torsion. *Orthop Clin North Am* 1980;11:39-50.
4. Staheli LT, Corbett M, Wyss C, King H. Lower-extremity rotational problems in children. Normal values to guide management. *J Bone Joint Surg [Am]* 1985;67:39-47.
5. Staheli LT. Torsional deformity. *Pediatr Clin North Am* 1986; 33:1373-83.
6. Bruce RW Jr. Torsional and angular deformities. *Pediatr Clin North Am* 1996;43:867-81.
7. Yorgancıgil H, Özerdemoglu RA. Alt ekstremite torsiyonel deformitelerinin cinsiyet ve yaşa göre dağılımları. *Acta Orthop Traumatol Turc* 1998;32:152-4.
8. Ryan DJ. Intoeing: a developmental norm. *Orthop Nurs* 2001; 20:13-8.
9. Gelberman RH, Cohen MS, Desai SS, Griffin PP, Salamon PB, O'Brien TM. Femoral anteversion. A clinical assessment of idiopathic intoeing gait in children. *J Bone Joint Surg [Br]* 1987;69:75-9.
10. Nagamine R, Miyanishi K, Miura H, Urabe K, Matsuda S, Iwamoto Y. Medial torsion of the tibia in Japanese patients with osteoarthritis of the knee. *Clin Orthop Relat Res* 2003; (408):218-24.
11. Sass P, Hassan G. Lower extremity abnormalities in children. *Am Fam Physician* 2003;68:461-8.
12. Svenningsen S, Apalset K, Terjesen T, Anda S. Regression of femoral anteversion. A prospective study of intoeing children. *Acta Orthop Scand* 1989;60:170-3.
13. Dietz FR. Intoeing-fact, fiction and opinion. *Am Fam Physician* 1994;50:1249-59.