Hip motion related to age and sex

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In a selected population 4 years old to adult age, 1,522 hips in 761 healthy subjects of both sexes were studied. Arcs of passive motion of the hip were measured by the technique recommended by the American Academy of Orthopaedic Surgeons. The lower and upper limits of normal range of hip motion in all the planes were established for both sexes in the different age groups.

We found that the amplitude of most hip motions decreased with age. Females had higher ranges of total hip motion, total rotation, internal rotation, and abduction compared with males.

The limits for normal hip motion at different ages are of importance when evaluating disorders of the locomotor system.

Generalized joint hypermobility is associated with congenital dislocation of the hip (Carter and Wilkinson 1964, Wynne-Davies 1970), hereditary diseases like Marfan and Ehlers-Danlos syndrome (Grahame 1971), and the so-called hypermobility syndrome (Kirk et al. 1967). Decreased range of hip motion is found in various hip diseases, and joint hypomobility is associated with juvenile-onset diabetes (Rosenbloom et al. 1981) and adolescent low-back pain (Fairbank et al. 1984). In sports medicine, injuries have been related to both hypomobility and hypermobility (Nicholas 1970).

The pattern of hip rotation is also of importance, as subjects with an intoeing gait due to increased femoral anteversion have an excess of internal rotation (Cyvin 1977). According to Giladi et al. (1987), an excess of external hip rotation is associated with an increased risk of stress fracture in soldiers.

Data exist concerning some hip motions at different ages (American Academy of Orthopaedic Surgeons 1972, Allander et al. 1974, Coon et al. 1975, Cyvin 1977, Boone and Azen 1979, Roaas and Andersson 1982, Staheli et al. 1985), but we have found no studies of hip motions in all the planes related to age and sex.

The purpose of the present study was to define the upper and lower limits of the normal range of hip motion in both sexes in a selected population 4 years old to adult age.

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Subjects and methods

Hip mobility in 1,522 hips of 761 apparently healthy subjects was examined (Tables 1 and 2). All the subjects lived in the city of Trondheim. The 4- and 6-year-old children were examined in 14 kindergartens. The 8- and 11-year-old groups were pupils in one elementary school. The subjects in the adult group were students from the nursing school (59 females and 9 males) and from the technical school (45 females and 93 males). In the adult group the average age of both females and males was 23 years (SD 5.5 and 2.7). All the subjects were examined at the school or kindergarten in a separate room made available for the study.

Measuring technique

The principles recommended in the manual of the American Academy of Orthopaedic Surgeons (1972) were used. All the measurements were carried out by 2 examiners. One performed the motion and the other measured the arc of motion with a goniometer. We measured the passive motion without exerting undue force to increase the range. An ordinary goniometer with long limbs and an examination bench were employed. All the angles were measured to the nearest 5°. Because there was no difference between the motions of the right and left hips in any one plane or direction, the average for both limbs for each subject was used in all the measurements.

Flexion was measured supine with the contralateral leg extended. Abduction was measured supine. One limb of the goniometer connected the anterior superior iliac spine on both sides and the other limb was parallel with the femur in full passive abduction. Adduction

was measured in the same way. Extension was measured prone with extended knees. Rotation was measured prone with extended hips and the knees flexed to 90°. The pelvis was stabilized by the examiner's hand to prevent rotation of the pelvis. The total range of hip motion is the sum of motions in both directions in all three planes. In the 8- 11-, and 15-year-old children, the height and weight were measured.

Student's *t*-test and Pearson's correlation test were used. *P*-values below 0.05 were regarded as significant.

Results

Hip motion related to sex. Females had higher values than males for total range of hip motion, total rotation, internal rotation, and abduction in all the age groups. The same was true for flexion and adduction in children 11 and 15 years of age and in adults. Males had higher external rotation than females in 4- and 6-year-old children and in adults.

Hip motion related to age. In females (Table 1) there was a marked reduction in the total range of hip motion from 4 years of age to 11 years of age, but little reduction thereafter. The same was found for flexion. Internal rotation decreased from 6 to 11 years, and abduction decreased throughout childhood. Total rotation decreased up to 15 years. In males most parameters decreased with age (Table 2).

Hip motion related to height and weight. There was no correlation between total rotation and height, weight, or height-weight ratio in any 8-15-year-old age group, neither in females nor in males.

Table 1. Hip motion in females (in degrees). Mean values *2 SD*

	4 year n 52		6 year n 52		8 year n 52		11 year n 69		15 year n 57		Adults n 104	
Flexion	151	*140–162*	149	*135–162*	146	*136–157*	139	*126–153*	141	*129–153*	141	*127–155*
Extension	29	*24–35*	26	*15–38*	27	*21–34*	25	*10–40*	26	*19–33*	26	*16–35*
Abduction	55	*46–64*	53	*43–62*	50	*41–58*	46	*35–56*	46	*36–57*	42	*35–50*
Adduction	30	*25–35*	30	*25–36*	28	*22–34*	29	*21–35*	28	*21–35*	30	*24–37*
Internal rotation	60	*40–80*	58	*41–75*	57	*40–73*	50	*33–68*	48	*31–66*	52	*34–71*
External rotation	44	*25–63*	44	*29–59*	43	*27–58*	42	*27–57*	42	*28–56*	41	*25–56*
Total rotation	104	*89–119*	102	*86–119*	99	*84–115*	92	*77–108*	90	*75–105*	92	*73–112*

Table 2. Hip motion in males (in degrees). Mean values *2 SD*

	4 year n 51		6 year n 50		8 year n 52		11 year n 65		15 year n 57		Adults n 102	
Flexion	149	*137–161*	147	*138–157*	146	*134–158*	137	*121–152*	138	*124–152*	137	*125–148*
Extension	28	*21–34*	25	*12–38*	27	*22–33*	25	*12–38*	25	*18–32*	23	*16–30*
Abduction	53	*45–61*	50	*41–60*	47	*41–53*	44	*33–55*	42	*33–50*	40	*33–47*
Adduction	30	*26–36*	30	*26–34*	28	*23–35*	29	*23–34*	29	*23–34*	29	*23–35*
Internal rotation	51	*36–67*	51	*33–69*	51	*33–70*	46	*32–61*	41	*26–56*	38	*23–53*
External rotation	48	*33–62*	47	*29–65*	42	*23–62*	42	*27–58*	43	*29–57*	43	*29–56*
Total rotation	99	*81–117*	98	*83–113*	94	*83–113*	88	*72–105*	84	*68–100*	81	*67–96*

Table 3. Comparison of estimated ranges of hip motion in adults (degrees)

	Own study[a]	Roaas and Andersson[a]	AAOS	Boone and Azen[ab]	Kapandji
Flexion	137	120	113	121	140
Extension	23	9	28	10	30
Abduction	40	39	48	46	45
Adduction	28	30	31	27	30
Int. rot.	38	32	35	47	40
Ext. rot.	43	33	48	47	60
Tot. rot.	81	65	83	94	100

[a] In males.
[b] Active motion.

Discussion

We hope our data on normal ranges of hip mobility will be useful for evaluation of patients with hip disorders and with hypomobility and hypermobility syndromes. When using our tables, it should be emphasized that the same measurement technique should be applied. When comparing our results with those of earlier studies (Table 3), several points regarding the measuring methods should be discussed.

We measured the passive motions like most other studies, whereas Boone and Azen (1979) used active motions. The correlation between active and passive motions is not known. However, we recommend that passive mobility be used, especially in younger children, who often have difficulties in cooperating when measuring active motions.

In all the studies, hip flexion has been examined with the patient supine. The knee on the examined side was flexed in our study, as well as in most others. However, extended knees were used by Ekstrand et al. (1982), who wanted to assess the muscle tightness in soccer players. In our study, the other hip was in a neutral position, the leg resting flatly on the bench, and therefore we had little control of pelvic motion. The results are in agreement with those of Kapandji (1970) and Ahlbäck and Lindahl (1964), while others report considerably lower values for flexion (American Academy of Orthopaedic Surgeons 1972, Roaas and Andersson 1982). One probable reason for this discrepancy is that the pelvis was better stabilized in the latter studies, as Roaas and Andersson (1982) flexed the opposite hip to stabilize the pelvis.

We measured hip extension with the patient lying prone, and found, like Ahlbäck and Lindahl (1964), this method to be somewhat arbitrary. The reasons might be difficulties in stabilizing the pelvis, and that, as in hip flexion, there is no definite end point. Our results are in agreement with American Academy of Orthopaedic Surgeons (1972) and Kapandji (1970), but higher than Roaas and Andersson (1982), who measured 30–40-year-old males. Ekstrand et al. (1982) measured hip extension with the subject supine: the leg was held outside the bench and the opposite hip flexed to stabilize the pelvis. They used another recording technique and their results cannot be directly compared with ours. Their method involves greater demands upon the cooperation of the patient and can hardly be used as a routine method.

The methods employed in various studies differ little when measuring hip abduction and adduction, and our results are very similar to those of others.

Hip rotation can be measured prone, with extended hips and flexed knees, or supine, with 90° of flexion of the hips and knees. The former is the method most widely used and the method employed in this study. Gelberman et al. (1987) felt that the latter method had a better correlation with femoral anteversion in patients with an intoeing gait. Our results accord with the American Academy of Orthopaedic Surgeons (1972), but are 6–10° higher than Roaas and Andersson (1982), who examined older individuals.

We found that the amplitude of most hip motions decreased with age. However, there was a striking difference in the amount of reduction between the different motions. The pattern was similar for flexion, abduction, internal rotation, and total rotation, which decreased considerably with increased age, as opposed to external rotation, adduction, and extension, where the reduction was much smaller or lacking. Our findings are very consistent with those of Boone and Azen (1979), who stated that hip abduction in males decreased 10–15° per decade for the first 20 years of life. For total rotation a similar pattern of decrease with age was reported in adolescents by Fairbank et al. (1984) and in adults by Allander et al. (1974).

The generally greater hip motion in females corresponds well with Beighton et al. (1973). However, Allander et al. (1974) and Fairbank et al. (1984) did not find any sex difference concerning total hip rotation in adults and adolescents, respectively.

In agreement with Beighton et al. (1973), we did not find any correlation between height, weight, or height/weight ratio and total hip rotation.

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