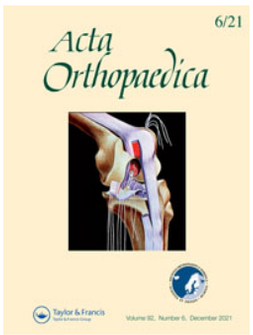

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NORMAL RANGE OF MOTION OF THE HIP, KNEE AND ANKLE JOINTS IN MALE SUBJECTS, 30–40 YEARS OF AGE

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Studies of the normal range of joint motion in human adults are uncommon, and frequently used references are based on materials not immediately accessible. The present paper reports on ranges of motion in healthy male subjects, 30–40 years old, in a randomized sample from the population in the city of Göteborg. It is based on 210 hips, 180 knees and 192 ankle joints. Arcs of passive motion were measured by techniques suggested by the American Academy of Orthopaedic Surgeons. Significant differences were found between the obtained measurements and previous referenced studies. The differences can be due to the measurement procedure, difficulties in measurement technique, the patient material, and inter-individual variations. There was no statistically significant difference between the motions of the right and left side, and it is therefore suggested that a patient's healthy limb can be used for comparison with the affected side in the presence of disease or a lesion.

Key words: ankle; hip; human adult; joint motion; knee

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Clinical measurements of the motion of joints are routinely used to assess injuries and diseases in the locomotor system. There are very few studies, however, in which joint motion in normal populations have been surveyed and reported. One well-known source for average ranges of joint motions is the handbook of the American Academy of Orthopaedic Surgeons (AAOS) (1965). This book describes estimates of joint motions obtained from three referenced sources, but as pointed out by Boone & Azen (1979) neither the populations nor the measurement methods are described in these surveys.

Joint motion varies with age, and is generally more restricted in the older age group. Boone & Azen (1979) showed a significant decrease in joint motions between men aged 1–19 years and men aged 20–54 years. They collected their data from 109 male volunteers ranging in age from 18 months to 54 years. The method of selection of subjects was not reported, except that they were healthy and right-handed.

The purpose of the present paper is to report on ranges of hip, knee and ankle joint motion in randomly selected healthy men, 30–40 years old. These men were investigated in a study comparing the injury rate in the general population and in soccer players.

SUBJECTS

A random sample from the male population in the city of Göteborg, aged 30–40 years, was selected from the church registry, which by law must be updated each month. The total population so obtained was 537 subjects of which 365 (68 per cent) were interviewed and investigated as a control group for patients with myocardial infarction (Bergstrand 1980). A random sample of these, 108 subjects, was studied with respect to injuries, diseases and disabilities of the lower limbs.

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All subjects with no previous injury or disease in the joints of the lower extremity were included in the present study. The number of hips included were 210 (105 subjects), the number of knees 180 (90 subjects), and the number of ankle joints 192 (96 subjects).

METHOD

Arcs of passive motion of the hips, knees and ankles were measured in the basic planes using an ordinary goniometer. The beginning and ending positions of each motion were measured once on the left and once on the right side.

The terminology and techniques of measurements were those suggested in the handbook of the AAOS (1965). The motions of the ankle were measured with the patient supine and the knee in slight flexion (about 45 degrees). Extension (dorsi-flexion) and flexion (plantar-flexion) of the tibiotalar joint were measured, as well as valgus (eversion, pronation, abduction and dorsi-flexion) and varus (inversion, supination, adduction and plantar-flexion) motions of the foot. The ranges of knee motion were also measured with the patient supine. The knee joint motions were recorded as 0 degrees for complete extension, and flexion was measured from this point. Hyperextension was recorded as minus degrees. Hip flexion was determined with the subject supine. The opposite hip was flexed on the abdomen and held in this position by the subject. Hip extension and rotation was determined with the patient prone and the knee flexed, while hip abduction and adduction were measured with the subject supine and the knee extended. All measurements were done by one investigator and recorded to the nearest 5 degrees.

The statistical analysis consisted of calculations of means and standard deviations. Student's *t*-test was used to compare the ranges of motions on the right side with the left side and to compare the results of the present study to those found by Boone & Azen (1979).

RESULTS

The range of the motion of the hip, knee and ankle joint is given in Table 1. The distribution of measured angles was approximately normal, as illustrated in Figure 1. There was no statistically significant difference between the motions of the right side and the left side. The inter-individual variation was significant. Hip joint flexion varied from 90 to 150 degrees (mean 120°), extension from 0 to 35 degrees (mean 9.5°), abduction from 15 to 55 degrees (mean 38.5°), adduction from 15 to 45 degrees (mean 30.5°), internal rotation from 20 to 50 degrees (mean 32.5°), and external

Table 1. Range of motion (degrees) of the hip, knee and ankle joints. Mean value and, within parentheses, the standard deviation. Comparison is made with the ranges given by the American Academy of Orthopaedic Surgeons (AAOS), and Boone & Azen (B & A). Student's t-test was used to compare the present results to those of B & A

Joint	Motion	Right	Left	AAOS	B & A
Hip	Extension[1]	9.4 (5.3)	9.5 (5.2)	28	12.1 (5.4)
(n=105)	Flexion	120.3 (8.3)	120.4 (8.3)	113	121.3 (6.4)
	Abduction	38.8 (7.0)	38.4 (7.3)	48	40.5 (6.0)
	Adduction[1]	30.5 (7.3)	30.5 (7.3)	31	25.6 (3.6)
	Int. rotation[1]	32.6 (8.2)	32.5 (8.2)	35	44.4 (4.3)
	Ext. rotation[1]	33.6 (6.8)	33.7 (6.7)	48	44.2 (4.8)
Knee	Extension	(–)1.6 (2.8)	(–)1.7 (3.0)	10	–
(n=90)	Flexion[2]	143.8 (6.4)	143.7 (6.6)	134	141 (5.3)
Ankle	Extension[1] (dorsiflexion)	15.3 (5.8)	15.3 (5.8)	18	12.2 (4.1)
(n=96)	Flexion[1] (plantar)	39.7 (7.5)	39.6 (7.7)	48	54.3 (5.9)
	Valgus[1] (eversion)	27.6 (4.6)	27.9 (5.0)	18[a]+5[b]	19.2 (4.9)[a]
	Varus[1] (inversion)	27.7 (6.9)	27.8 (6.9)	33[a]+5[b]	36.2 (4.2)[a]

a. fore-foot. 1. $P < 0.01$.
b. hind-foot. 2. $P < 0.05$.

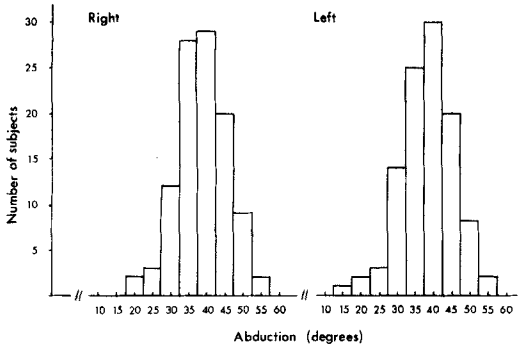

Figure 1. Hip abduction. The distribution was approximately normal for all motions.

rotation from 10 to 55 degrees (mean 33.6°). Similarly, for the knee joint flexion varied from 115 to 160 degrees (mean 143.7°) and extension from 0 to −10 degrees (mean −1.6°). The ankle dorsi-flexion was between 5 and 40 degrees (mean 15.3°), plantar flexion from 10 to 55 degrees (mean 39.6°), valgus motions of the foot 15 to 50 degrees (mean 27.7°), and varus motions 15 to 50 degrees (mean 27.7°). Significant differences were observed between the present values and most of those given by Boone & Azen (1979). The motions which differed with statistical significance are marked in Table 1.

DISCUSSION

There are very few studies of the normal range of motion of the hip, knee and ankle joints. Furthermore, frequently used references about the range of motion are based on materials not immediately accessible to the reader (AAOS 1965, Daniels & Worthingham 1972, Kapandji 1970). We have found only two studies in which the range of hip motion in adults has been investigated in all basic planes. One of these studies (Glanville & Kreezer 1937) is based on 10 males, 20–40 years old, and the other one (Boone & Azen 1979) on 56 males, 20–50 years old. Both include data on the range of motion in the knee and ankle joints. Data on knee motions are also available in studies by Györy et al. (1976) and Mitchell et al. (1975), and on ankle motions in studies by Sammarco et al. (1973) and Weseley et al. (1969).

As Boone & Azen's study is the most recent, with the greatest number of subjects, and includes all joints of interest here, we have chosen to use their results for comparison. The differences in results were often statistically significant. This may be due to the measurement procedure. In the present study passive motion only was examined while Boone & Azen studied active range of motion. Furthermore, for rotation of the hip joint a prone position was used by us, while Boone & Azen measured with the subjects sitting, i.e. the hip was flexed in their study.

Another reason why differences can exist between investigations is the difficulty in recordings of the ranges of motion. It has previously been shown that the range of motion of joints can only be determined accurately using radiography (Ahlbäck & Lindahl 1964). We measured all angles to the nearest 5 degrees, a technique usually adopted in clinical practice. As in clinical practice no attempt was made to study the intra-test reliability. However, one experienced orthopaedic surgeon did all measurements while the other was present, recording the obtained values.

A third reason for the differences may be the inter-individual variation. Thus, the total range of motion in the hip joint varied from 150 to 390 degrees, in the knee joint from 115 to 170 degrees, and in the ankle joint from 15 to 95 degrees with respect to extension and flexion and 30 to 100 degrees with respect to varus and valgus. As differences between individuals are so great it is obviously necessary to use normal values for any range of motion in the lower extremity joints with caution.

The amplitudes of motion of the left and right joints were consistantly similar. Therefore, the motions of the joints of a patient's healthy limb can routinely be used for comparison with those of the affected side in the presence of disease or a lesion. This conclusion was made also by Boone & Azen (1979) and is confirmed in the present study. When a bilateral disability is present or is expected, figures such as those presented here can be used as comparative data but great caution is needed and the same measurement method must be used.

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