

The measurement of wrist kinematics in children 4 to 16 years old and the comparison of the scapholunate distance with adult values

Çocuklarda (4-16 yaş) el bileği kinematiği ve skafolunat mesafenin erişkin değerleriyle karşılaştırılması

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Amaç: Çalışmamızda, erişkinler için bildirilen el bileği kinematik indekslerinin (rotasyon merkezi, karpal yükseklik, karpal-ulnar mesafe), üçüncü metakarp uzunluğunun ve skafolunat mesafenin çocuklardaki yer ve değerlerini saptamaya çalıştık.

Çalışma planı: El bileği ve/veya önkol travmasıyla başvuran 4-16 yaş grubu hastalardan karşı taraf el bileği grafisinin karşılaştırma amacıyla çekildiği 41 olgu (24 kız, 17 erkek) çalışmaya alındı. Çocuklar cinsiyet ve taraf farkı dikkate alınmadan kronolojik yaşlarına göre ikişer yıl aralıklarla altı gruba ayrıldı. Sağlam el bileklerinin standart arka-ön grafileri üzerinde yapılan ölçümlerin ortalamaları hesaplandı ve sonuçlar istatistiksel olarak yorumlandı.

Bulgular: Karpal yükseklik, karpal-ulnar mesafe ve üçüncü metakarp uzunluğu tüm gruplarda anlamlı derecede farklılık gösterdi. Ancak karpal yüksekliğin ve karpal-ulnar mesafenin üçüncü metakarp uzunluğuna oranları yaş grupları arasında ve erişkin değerleriyle benzerlik gösterdi. Skafolunat mesafe ise tüm yaş gruplarında birbirinden ve standart erişkin değerinden anlamlı derecede farklı bulundu.

Çıkanmlar: Karpal yüksekliğin ve karpal-ulnar mesafenin üçüncü metakarp uzunluğuna olan oranlarına ait erişkin değerleri, çocuklar için de standart değerler olarak kabul edilebilir. Ancak, çocuklarda skafolunat ayrışmayı belirlerken normal erişkin röntgen ölçüm değeri tanı ölçütü olarak kullanılmamalıdır.

Anahtar sözcükler: Yaş faktörü; antropometri; kemik gelişimi; karpal kemikler/radyografi; çocuk; referans değeri; skafoid kemik/radyografi; el bileği/anatomi ve histoloji/radyografi; el bileği eklemi/radyografi.

Objectives: We sought to determine the position and values of the kinematic indices of the wrist (center of rotation, carpal height, carpal-ulnar distance), the third metacarpal length, and the scapholunate distance for children and compared the results with those reported for adults.

Methods: The study included 41 children (24 girls, 17 boys; age range 4 to 16 years) who presented with wrist and/or forearm injuries, and whose radiographs of the other wrist had been obtained for comparison. The children were divided into six age groups separated by 2-year intervals regardless of gender or the side of the wrists involved. Measurements were made on standard posteroanterior radiographs of healthy wrists and the mean values obtained were statistically analyzed.

Results: The carpal height, carpal-ulnar distance and the third metacarpal length were significantly different in all age groups. The ratios of the carpal height and the carpal-ulnar distance to the third metacarpal length were similar both in the age groups and to those reported for the adult values. However, the scapholunate distance exhibited significant differences between the age groups and from the standard adult value.

Conclusion: The adult values given for the ratios of the carpal height and the carpal-ulnar distance to the third metacarpal length can be adopted as standard values for children. However, determination of the scapholunate dissociation in children should not be based on the normal range given for adults.

Key words: Age factors; anthropometry; bone development; carpal bones/radiography; child; reference values; scaphoid bone/radiography; wrist/anatomy and histology/radiography; wrist joint/radiography.

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Wrist kinematic indices and the scapholunate distance play an important role in the diagnosis and treatment of carpal diseases and traumas. Standard measurements for adults have been developed in many studies using direct radiographs.^[1-4] Standardized values obtained from these studies are used to differentiate normal and pathological situations for all age groups. However in children, in whom cartilage tissue is dominant and bone growth is not yet complete, these standardized measurements might be far from accurate.

Emphasizing this point, Kaawach et al^[5] performed an important study aiming to determine the normal values of scapholunate distance in children according to age groups and chronological changes. We have not encountered with another study intending to determine the standard values for carpal height/length of the third metacarpal, carpal-ulnar distance/length of third metacarpal which are to be used in the diagnosis of wrist pathologies in children. Moreover, there was also no study in the literature investigating the differences in carpal height, carpal-ulnar distance and length of the third metacarpal according to age groups.

We had two major objectives in the study: (i) To determine the pediatric values and importance of wrist kinematic indices (rotational center, carpal height, carpal-ulnar distance) and length of the third metacarpal, which are reported and standardized measurements for adults; (ii) being a valuable criteria for scapholunate dissociation, to determine the variability in the values of the scapholunate distance and to compare them with adult values.

Patients and method

The study group consisted of 41 patients aged 4-16 years who referred to the emergency department between Jan-May 2002, with traumas involving the wrist or forearm and whose contralateral wrists were evaluated radiographically for comparison. There were 24 girls and 17 boys. In two patients, both wrists were included in the study since only the soft tissues of the elbow were affected. None of the patients had a previous history of wrist pathology or radiographic abnormality. Patients were separated into six groups according to their chronological age with 2-year intervals.

Standard AP radiographs of the unaffected wrist were used to measure the center of rotation, scapholunate distance, carpal-ulnar distance, length of the third metacarpal, carpal height, and ratios between carpal height/length of third metacarpal, carpal-ulnar distance/length of third metacarpal. All of the measurements were performed by one of the authors.

The number of boys and girls, and right and left wrists in each group were not adequate for statistical analysis; therefore, the affected side and gender were not taken into consideration.

Kruskal-Wallis, Mann-Whitney U and Student's T test were used in the statistical evaluation.

Results

The center of rotation for the wrist was in the mid-proximal third of the capitate, similar to adults.

Mean values and standard deviations of the measurements are listed in Table 1 and statistical com-

Table 1. General demographics (Mean.±standard deviation)*

Age	Gender Girl/ Boy	Side Right/ Left	Scapholunate distance	Carpal- ulnar distance	3rd metacarpal length	Carpal height	Carpal height/ length of 3rd metacarpal	Carpal-ulnar distance/length of 3rd metacarpal
4-6	2/1	1/3	1±0	14.5±4.05	45.75±5.86	24.13±4.67	0.52±0.05	0.38±0.12
6-8	2/1	1/2	4±2.18	15.67±3.06	44±2.65	24.67±3.52	0.56±0.05	0.35±0.08
8-10	3/2	1/4	5.48±2.8	15.42±3.4	47.67±5.93	25.5±3.15	0.54±0.07	0.32±0.06
10-12	6/1	0/7	3.12±3.17	18.89±2.76	52.45±7.15	25.23±4.74	0.48±0.11	0.36±0.04
12-14	5/3	2/7	2±0.82	18.73±2.76	59.45±4.04	31.45±3.82	0.53±0.08	0.34±0.09
14-16	6/9	2/13	0.98±0.3	19.82±3.27	63.54±5.1	33.44±4.9	0.52±0.08	0.31±0.04
Total	24/17	7/36	2.86±2.59	18.15±3.54	55.32±8.83	29.12±5.75	0.52±0.08	0.34±0.07

* Measurements are in millimeters.

Table 2. Statistical comparison of all patient values with those of adults

	Scapholunate distance	Carpal-ulnar distance	Length of 3rd metacarpal	Carpal height	Carpal height/Length of 3rd metacarpal	Carpal-ulnar distance/Length of 3rd metacarpal
Kruskal-Wallis	12.97	11.31	26.11	21.366	2.018	5
Degree of freedom	5	5	5	5	5	5
All groups	p<0.05	p<0.05	p<0.01	p<0.01	p>0.05	p>0.05

* All distance and length measurements are mean values in milimeters.

parisons of different age groups in Table 2.

Carpal height ($p<0.01$), carpal-ulnar distance ($p<0.05$) and length of the third metacarpal ($p<0.01$) showed statistically significant differences between all groups.

The ratio of carpal height to length of the third metacarpal did not demonstrate a statistically significant difference compared to the adult value (0.54 ± 0.03), in terms of the mean group value and age groups themselves ($p>0.05$). Similarly, the ratio of carpal-ulnar distance to length of the third metacarpal was not significantly different from the adult value of 0.30 ± 0.03 ($p>0.05$).

For the scapholunate distance, the mean value of the whole group showed a significant difference of ≤ 2 mm from the adult value ($p<0.05$). When different age groups were compared with the adult values, statistical evaluation could not be performed since there was only one measurement in the group 4-6 years, in the 6-8 years group, the measurement was found to be similar to adult values, all the other groups showed significantly higher results than adult values ($p<0.05$).

A radiographical demonstration of all measurements are shown in Figure 1.

In some radiographs, the contours of the scaphoid and the lunate bones were superimposed; thus, these patients were not included in the groups (Figure 2).

Discussion

Kinematic indices of the wrist and ratios determining the discrimination between normal and pathological conditions are defined in the literature, using AP radiographs of skeletally mature patients.^[1-4]

⁴⁾ Standardized values obtained from these measurements are used in the diagnosis of wrist pathologies of all age groups.

The adult values we have used in comparing different age groups were 0.54 ± 0.03 for carpal height, 0.30 ± 0.03 for ratio between carpal height and length of third metacarpal and ≤ 2 mm for the scapholunate distance.

In children, the epiphysis, metaphysis and cartilage bodies absorb most of the impaction forces. Therefore, rupture of the scapholunate ligament is a rare type of traumatic lesion for skeletally immature people.^[6-8] The scaphoid shows an exantric ossification and his ossification is symmetrical in rate. This finding causes comparative evaluation of scapholunate measurement using the contralateral wrist inaccurate.^[7]

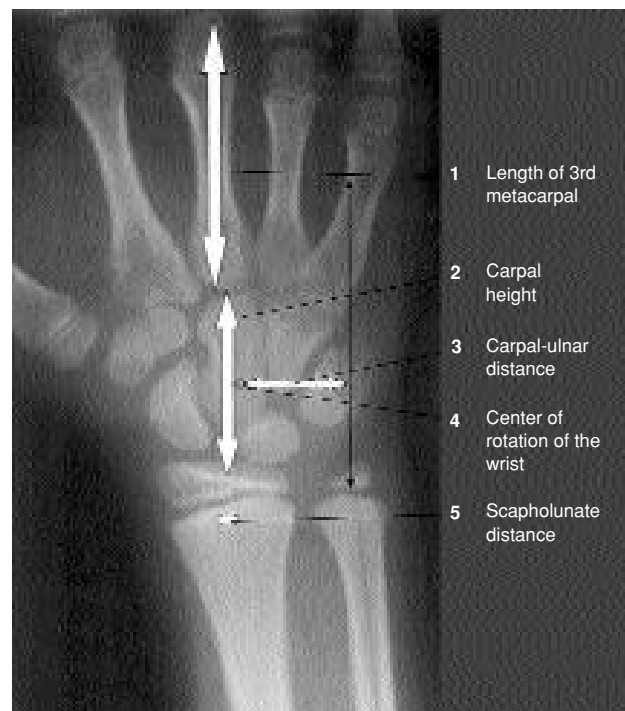


Figure 1. AP radiograph of the wrist of a seven year-old boy. Center of rotation is determined, scapholunate distance, carpal-ulnar distance, length of third metacarpal are measured.

In the literature there was only one study aiming to determine the scapholunate distance chronologically according to bone age measurements.^[5] There was no other data, reporting the pediatric values for the other ratios discussed.

Patients were grouped according to chronological age.

The predominant cartilage structure in children causes a different AP radiograph compared to adults. Carpal height, carpal-ulnar distance and length of third metacarpal showed statistically significant differences in all age groups. However, the ratios were similar both among different groups and with adult values. The center of rotation was the same in children and adults. The scapholunate distance was significantly different in various age groups and was higher than the adult values. Despite the presence of a study^[9] indicating that a measurement of up to 5 mm could be taken as normal scapholunate values for asymptomatic wrist not having the cortical ring sign, we have taken the standard 2 mm as the upper limit of normal.

Working on the radiograph we also have encountered a previously reported problem concerning the



Figure 2. AP radiograph of the wrist in a thirteen year-old girl. Scapholunate distance could not be measured.

scapholunate distance. The scapholunate distance could not be determined in some AP radiographs since the bony contours could not be differentiated. In some studies this problem was solved by taking radiographs in different positions or with different tube angles; thus distinguishing the scapholunate interval.^[10,11] In our study, we have excluded some cases due to inability to perform measurements, since we have used contralateral AP radiographs used for comparison with the affected side.

In our study, we have reviewed the criteria indicated for evaluating wrist pathologies for the pediatric population. According to our results, we have concluded that normal adult values obtained from radiographs were not appropriate criteria to diagnose scapholunate dissociation. The major drawback of the study was the limited number of patients, causing side and gender differentiation to be impossible. Therefore, our study should be evaluated as a preliminary study, until another larger study aiming to contribute to the standardization of the pediatric wrist is performed.

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