

# ULNAR VARIANCE AND THE SHAPE OF THE LUNATE BONE A RADIOLOGICAL INVESTIGATION

A. H. SCHUURMAN<sup>1</sup>, M. MAAS<sup>2</sup>, P. F. DIJKSTRA<sup>2</sup>, J. M. G. KAUER<sup>3</sup>

**The authors designed a study to test the hypothesis that the length of the ulna might affect the shape of the lunate bone because of long-term molding during life. This might then be useful to predict the presence or absence of a dynamic or static ulna plus by the shape of the lunate bone.**

**In a prospective study, posterior-anterior wrist xrays were taken in a standard fashion in 68 patients with a mean age of 34.5 years. Dominance, grip strength, ulnar variance and the shape of the lunate were recorded.**

**Lunate shape, type 1, which is the least molded, was seen most frequently on both the left and right side and did not correlate with the dominant side. The most molded, type 3, was seen less frequently and almost exclusively on the nondominant side. No correlation was found between dynamic ulna plus and the type 3 lunate.**

**Following statistical analysis, no correlation between ulnar variance and lunate shape was found, indicating that the shape of the lunate bone had no predictive value for predicting the presence or absence of a dynamic ulna plus variance. The hypothesis that the length of the ulna might influence the ultimate shape of the lunate could not be demonstrated.**

**Keywords :** lunate bone shape ; ulnar variance.

**Mots-clés :** semi-lunaire ; forme ; variance ulnaire.

Ulnar variance is the roentgenographic difference of the length of the ulna relative to the radius. Positive ulna variance or ulna plus refers to an ulna longer than the radius, while the opposite is true in the ulna minus or negative ulnar variance. Obermann (6) correlated lunate shape and ulnar length in 68 patients. Although he found a 13% incidence of type 1, 62% type 2 and 25% type 3, he found no correlation between type 1 and ulna length (even distribution in all). Type 2 was found less often in the ulna minus group and type 3 was most often found in the ulna plus group. Unfortunately no statistical analysis was performed.

This study was performed to test the hypothesis that the length of the ulna or ulnar variance and grip will effect the shape of the lunate during life (long-term molding). Previous studies have demonstrated that grip has a profound effect (positive increase) on ulnar variance (2) and that ulnar variance is negative in the majority of fetal and adolescent wrists (4), but positive in adults (9). Some time during life, there is a gradual change of ulnar variance from negative to positive. The combination of the latter and grip strength affects the shape of the

## INTRODUCTION

In 1966 Antuna Zapico (in 11) classified the lunate bone according to its shape as three types while trying to find a relationship between lunate shape and ulna variance in Kienbock's disease.

<sup>1</sup> Department of Plastic, Reconstructive and Hand Surgery, University Medical Center Utrecht, The Netherlands.

<sup>2</sup> Department of Radiology, Academic Medical Center, University of Amsterdam, The Netherlands.

<sup>3</sup> Department of Anatomy and Embryology, University Medical Center Nijmegen, The Netherlands.

Correspondence and reprints : A. H. Schuurman, Department of Plastic, Reconstructive and Hand Surgery, University Medical Center Utrecht, PO Box 85500, 3508 GA, Utrecht, The Netherlands. E-mail : a.schuurman@chir.azu.nl.

lunate in adults. Furthermore the predictive value of only the shape of the lunate in predicting the presence or absence of a dynamic ulna plus variance was investigated.

### MATERIALS AND METHODS

Posterior-anterior radiographs of each wrist were made in 68 consecutive adult patients (27 males, 41 females) visiting the outpatient clinic of the department of plastic, reconstructive and hand surgery of the Academic Medical Center, University of Amsterdam. The median age was 33.0 years, the mean age 34.5 years, range 18-65 years (mean age males 35.4 years, mean age females 33.9 years). Six patients were left-sided dominant (3 males, 3 females), 62 right-sided dominant (24 males, 38 females). All were being evaluated for a variety of disorders of the hand and/or wrist. Age, dominance and grip strength were recorded. Pregnant patients, patients with a history of rheumatoid arthritis, evident osteoarthritis, fractures and patients younger than 18 years were excluded. Radiographs of both wrists were all taken in standard zero-rotation posterior-anterior (PA) and lateral projections according to Epner *et al.* (1), Palmer *et al.* (7), Hardy *et al.* (3), Schernberg (10) and Larsen *et al.* (5). The radiographs were obtained with the patient's shoulder abducted 90°, the elbow flexed 90° and the hand flat on the xray table. In the PA-view the long axis of the radius and the third metacarpal bone were colinear to ensure that no radial or ulnar deviation was present. PA-projections (as described above) with maximum grip strength were also obtained by asking the patients to maximally grip the dynamometer while the xray was made. The grip strength was recorded using a Jamar Dynamometer. AGFA mammoray film was used with a film-focus distance of one meter and a beam inclination angle of zero degrees for each exposure (50 kv, 20 mas), centered on the head of the capitate. The estimated radiation exposure was less than 0.1 mSv, far less than the 0.5 mSv of category one of the WHO radiation guidelines. The medical ethics committee of our hospital approved the study. All patients gave informed oral consent to the study.

Ulnar variance determinations were made using the template with concentric semicircles at one-mm increments (Palmer 1982) (7). Two observers classified the shape of the lunate bone according to figure 1. Statistical analysis was done using the Statistical Package for the Social Sciences (SPSS 7.5) computer program.

### RESULTS

In 41.9% of the cases an ulna plus configuration was seen (more than 0 mm), a neutral ulna in 25.7% and in 32.4% an ulna minus. Average ulnar variance was plus 0.22 mm on the left and plus 0.10 mm on the right. While making a fist the ulnar variance increased to plus 0.50 mm on the left and to plus 0.28 mm on the right. Maximum grip increased ulnar variance to plus 2.37 mm on the left and plus 2.18 mm on the right. Overall the average ulnar variance was plus 0.16 mm in the neutral PA-position, plus 0.39 mm while making a fist and plus 2.27 mm with maximum grip (table I). The average grip strength on the dominant and nondominant side is reported in table II.

A symmetrical distribution of the different types of lunate shape was seen between left and right. Type 1 was most frequently seen on both the left and right side (35 left, 32 right) and did not correlate with the dominant side. Type 3 was seen the least number of times and almost exclusively on the nondominant side (table III).

After creating two groups : (1) ulnar variance less than or equal to zero and (2) ulnar variance greater than zero, we compared the lunate type for the left and right side for these two groups. No significant difference could be determined between ulnar variance, lunate type of the left or right side (paired T-test :  $p = 0.06$  for the left side and  $p = 0.7$  for the right side). The lunate type had no statistical relationship with ulnar variance.

Table I. — Ulnar variance on the left, right and average

Ulnar variance mm	Left	Right	Average
PA neutral	0.22	0.10	0.16
PA fist	0.50	0.28	0.39
PA max. grip	2.37	2.18	2.27

Table II. — Grip strength on the dominant and nondominant side

Grip strength (kg)	Range	Average
Dominant	9 – 61	28.1
Nondominant	3 – 58	26.0

Table III. — Frequency of Lunate shape type on the dominant and nondominant side

Lunate		Dominant side		Non dominant side
	type	No.	No.	No.
Left	1	35	3	32
	2	24	2	22
	3	9	1	8
Right	1	32	31	1
	2	26	22	4
	3	10	9	1

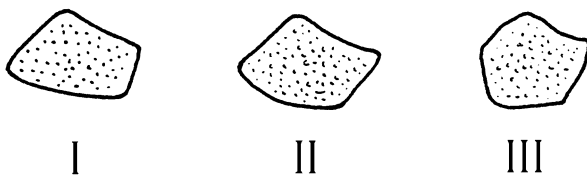


Fig. 1. — Lunate bone shape and type according to Zapico.

## DISCUSSION

At approximately the 25<sup>th</sup> day of gestation the upper extremity limb buds appear. By day 35 the mesenchymal condensation of the future carpal bones and associated structures are seen. During fetal development the ulna appears to retreat from the carpus (4). It is during this period that Kauer found only ulna minus i.e. the ulna being relatively short relative to the radius (4). However Sanderson *et al.* (9) recently reported that aging could have an effect on the length of the ulna, resulting in an ulna plus configuration. Biomechanical studies by Palmer have not only shown that about 80% axial force crosses the wrist on the radial side and 20% on the ulnar side, but that increasing the length of the ulna by 2.5 mm gave an increase in the axial force to 42% (8).

In 1966 Zapico (11) classified the lunate bone according to its shape into three types, while trying to find a relationship between lunate shape and ulna variance in Kienbock's disease (fig. 1). Theoretically the gradual increase in ulna length with

ageing and the effect of loading (grip) during life and dominance could be responsible for the lunate shape owing to long-term molding of the lunate during growth and over time. This would imply that an ulnar plus configuration would correspond to a Zapico type 3 lunate.

However, although Zapico described lunate shapes corresponding to ulnar variance, we, like Obermann (6), found no correlation between ulnar variance and lunate type. It was thus not possible to prove that aging or loading of the wrist influenced the shape of the lunate bone. No evidence could be found that the shape of the lunate had a predictive value in predicting the presence or absence of a (static or dynamic) ulna plus variance. In our population average grip strength was similar on the dominant and nondominant side, yet the largest variation of incidence of lunate type was seen on the nondominant side. This suggests that dominance and grip have no influence on molding of the lunate. Possible flaws of the study could be that the age of our population varied from 18 to 65. More elderly patients might have shown more type 3 lunates. Further, dominance affects grip strength, yet dominance was not evenly divided (6 of 68 left-sided).

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## SAMENVATTING

*A. H. SCHUURMAN, M. MAAS, P. F. DIJKSTRA, J. M. G. KAUER. Ulnar variatie en de vorm van de het os lunatum. Een radiologische studie.*

Een studie werd verricht om de hypothese te toetsen dat, de lengte van de ellepijp de vorm van het os lunatum zou kunnen beïnvloeden door lange termijn modulering. Mogelijk dat dan de aan of afwezigheid van een dynamische of statische ulna plus bepaald kan worden door alleen naar de vorm van het os lunatum te kijken.

In een prospectieve studie werden bij 68 patiënten, met een gemiddelde leeftijd van 34,5 jaar, op een standaard wijze posteroanterior röntgen foto's van beide polsen genomen. Dominantie, knijpkracht, ulnar variatie en de vorm van het os lunatum werden bepaald.

Het minst gemoduleerde type 1 lunatum werd het meest gezien aan zowel de linker als de rechter zijde en correleerde niet met dominantie. Type 3, welke het meest gemoduleerd is, werd minder vaak gezien en nagenoeg alleen aan de niet-dominante zijde. Geen correlatie kon worden aangetoond tussen een dynamische ulna en type 3 lunatum.

Na statistische bewerking kon geen correlatie tussen ulnar variatie en de vorm van het os lunatum worden aangetoond, zodat de vorm van het os lunatum geen voorspellende waarde heeft voor de aan of afwezigheid van een dynamische ulna plus variatie. De hypothese kon niet worden aangetoond.

## RÉSUMÉ

*A. H. SCHUURMAN, M. MAAS, P. F. DIJKSTRA, J. M. G. KAUER. Variance ulnaire et morphologie du semi-lunaire.*

Les auteurs rapportent les résultats d'une étude réalisée pour vérifier l'hypothèse selon laquelle la longueur de l'ulna pourrait affecter la morphologie du semi-lunaire du fait d'un modelage progressif au fil des ans. L'idée était de pouvoir utiliser ces données pour prédire la présence ou l'absence d'une variante ulna + dynamique ou statique à partir de la forme du semi-lunaire. Pour cette étude prospective, des radiographies de face du poignet ont été prises de manière standardisée chez 68 patients dont la moyenne d'âge était de 34,5 ans. On a noté la dominance, la force de préhension, la variance ulnaire et la morphologie du semi-lunaire.

C'est une morphologie de type 1, correspondant à un modelage minimum qui a été le plus fréquemment rencontrée au niveau du semi-lunaire aussi bien du côté gauche que du côté droit, sans corrélation avec le côté dominant. Une morphologie de type 3, correspondant au modelage le plus important, a été observée moins fréquemment, de façon quasi exclusive du côté non dominant. On n'a noté aucune corrélation entre la variante ulna + dynamique et la morphologie de type 3 du semi-lunaire.

L'étude statistique n'a montré aucune corrélation entre la variance ulnaire et la morphologie du semi-lunaire. Celle-ci n'a donc aucune valeur prédictive en ce qui concerne la présence ou l'absence d'une variance ulnaire dynamique. L'hypothèse selon laquelle la longueur de l'ulna pourrait influencer la forme du semi-lunaire n'a donc pas été vérifiée dans cette étude.