Ulnar variance and load transfer in the forearm during maximum grip: A finite element study

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Introduction/Aims

The aim of the study was to simulate the effects, ulnar variance has on the load distribution to the radius and ulna during maximal gripping and compare to previously published measurements, which used load cells placed on the forearm bones to measure the load ratio.

Material/Methods

Three finite element models were created of the whole wrist, including the distal end of the radius and ulna, 7 carpal bones (pisiform was omitted from the study) and the proximal third of the metacarpals. The finite element model was geometrically based on 3T MRI scans with resolution of 230x230 µm in plane resolution and with 700 µm slice thickness. The scans were digitised using Mimics software where three dimensional objects were created of the bones and meshed. The structure was assembled in Abaqus v.6.7 where the modelling was carried out. Subject specific loading conditions were applied to the metacarpals, where the subjects carried out grip strength measurements where the measured forces were converted into contact joint forces using a biomechanical model.

Results/Statistics

The load transfer percentage was calculated for the natural ulnar variance of each subject. The ulna was then moved 4.5mm in proximal and distal direction simulating negative variance and positive variance. The results are summarized in Table 1.

	Subject 1 [%]		**Subject 2 [%]**		**Subject 3 [%]**		**Cadaveric study [%]**	
Variance	**Radius**	**Ulna**	**Radius**	**Ulna**	**Radius**	**Ulna**	**Radius**	**Ulna**
- var	92.6	7.4	93.8	6.2	88.8	12.2	95.7	4.3
0	91.1	8.9	92.8	7.2	78.7	21.3	81.6	18.4
+ var	54.0	46.0	89.0	11.0	63.5	36.5	58.1	41.9

Table 1: The effect of positive and negative ulnar variance on forearm load transfer

Conclusions/Clinical Reference

From the results it can be seen a dramatic increase in the load transfer through the ulna for the positive variance simulation for two of the three subjects. The results are in coherence with the findings of Palmer and Werner (1984).