Normal anteroposterior laxity of the radiocarpal and midcarpal joints

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The patterns of laxity of normal wrists subjected to dorsal and volar stresses were analysed. Dorsal and volar displacement tests were carried out on both wrists of 50 subjects under image-intensifier control. Lateral projections in neutral, and dorsal and volar stress positions were taken to analyse the behaviour of the carpal bones. Varying degrees of capitolunate subluxation under dorsal and volar stress were noted. Dorsal displacement of the capitate appeared to be more prominent than volar displacement. The lunate either extended or subluxed dorsally in response to a dorsal stress, suggesting a different pattern of laxity for the radiolunate joint. These observations provide a baseline for the interpretation of dorsal and volar stress views in the symptomatic wrist.

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The normal wrist is inherently lax in many planes. Several authors have described the use of the dorsal or volar stress test when assessing pathological conditions of the ligaments. Abnormal displacement during the stress test is a pathological finding in instability of the wrist, but lack of information about the normal behaviour of the carpal bones under dorsal or volar stress makes it difficult to interpret this observation. The patterns of laxity of the normal radiocarpal and midcarpal joints under dorsal and volar displacement stresses were therefore studied.

Subjects and Methods

Fifty normal subjects (100 wrists) without a history of injury, arthritic disease or other dysfunction were examined. Wrist with symptoms which suggested ligamentous insufficiency, such as a painful clunk, weakness or swelling were excluded. There were 25 men and 25 women aged between 20 and 39 years. The age distribution was similar for both men and women. An image-intensifier unit (Fluoro-Scan; FluoroScan Imaging Systems, Northbrook, Illinois) with an image printing system was used to record the images.

The intensifier was positioned to give a lateral view of the wrist without interfering with the examination and in a neutral position, defined as alignment of the capitate with the radius in both planes. The scapholunate and the radiolunate angles were measured. Wrist which showed an abnormal angle, or possible instability, were excluded.

The stress examination consisted of the application of dorsal and volar displacement stresses to the hand while the forearm was supported and the hand held firmly. While applying the stress, the wrist was always aligned in a neutral position in both planes relative to the forearm which was also in a neutral position, midway between pronation and supination. The forearm was supported by grasping of its distal aspect in the examiner’s hand. With the examiner’s other hand maintaining the subject’s hand in a neutral position, the examiner’s thumb was placed on the palmar side at the level of the capitate-metacarpal joint in order to push the capitate dorsally into dorsal stress. Volar stress was applied by reversing the position of the examiner’s hands. Under image-intensifier control, the position of maximum displacement, as long as the subject could tolerate each stress, was taken and printed (Fig. 1). All procedures were carried out by the same manoeuvre.

At the midcarpal joint, displacement of the capitate was calculated with reference to the lunate in the dorsal and volar stress views. The displacement index, representing the amount of capitolunate subluxation, was defined as the percentage of displacement, as measured by the distance between the proximal aspect of the capitate and a line passing through the midline axis of the lunate. This was compared with the distance between the dorsal and volar lips of the distal lunate (Fig. 2). At the radiocarpal level, the behaviour of the lunate under dorsal and volar stress was observed and its rotation calculated from the alteration of the radiolunate angle between the resting and stressed images. These parameters were compared between men and women, dominant and non-dominant hands, and those subjects aged either 20 to 29 years or 30 to 39 years using an unpaired, two-tailed t-test. Significance was set at p < 0.05.
Results

The capitate tended to move out of the distal lunate fossa when under dorsal or volar stress. The degree of subluxation varied considerably between subjects. Dorsal displacement of the capitate was more prominent than volar displacement. The displacement index of the capitate ranged from 7.5% to 71.4% under dorsal stress, and from 0% to 24.8% under volar stress. The mean dorsal displacement index for women (38.2%, SD 11.9) was significantly higher than that for men (27.8%, SD 11.2) and was significantly higher (37.7%, SD 11.5) in subjects aged from 20 to 29 years than in those aged from 30 to 39 years (28.1%, SD 12.1). There was no significant gender- or age-dependent difference in the volar displacement index of the capitate. Neither was there significant difference between dominant and non-dominant wrists for either dorsal or volar displacement indices.

When under dorsal stress, the lunate always tended to be in an extended position. When its relationship with the distal radius was analysed, however, the lunate behaved differently in different subjects. This could be categorised into one of three types. In type I it extended, maintaining a constant joint space between the lunate and the distal radius (Figs 3a and 4a). In type II, the lunate extended, but was also displaced dorsally, resulting in a widening of the volar joint space (Figs 3b and 4b). In type III, the lunate subluxed dorsally, but without definite extension (Figs 3c and 4c). Type I was seen in 36% of subjects, type II in 51% and type III in 13%. When the mean dorsal displacement index of the capitate relative to the lunate was compared in the three types under dorsal stress, type III (22.4%, SD 10.8) had significantly lower values than either type I (33.7%, SD 13.7) or type II (35.0%, SD 11.0). When under volar stress the lunate appeared to become flexed and maintained its relationship with the lunate fossa of the distal radius without widening of the joint space or subluxation.

Discussion

Our study has shown the normal response of the carpal bones to dorsal and volar stresses. It appears that normal wrists have considerable variations in the degree and pattern of anteroposterior laxity. Schernberg\(^5\) analysed the stress views in normal and lax wrists. He reported that a lax joint showed more prominent dorsal displacement of the capitate than a normal wrist, although the definition of the lax wrist was not clear.

Dysfunction of the wrist associated with ligamentous laxity has been reported by several authors.\(^1,6-9\) Louis et al\(^7\) described a capitolunate instability pattern as a distinct form of instability. Johnson and Carrera\(^2\) reported chronic capitolunate instability of traumatic origin. The primary abnormal lesion was considered to be an insufficiency of the ligaments which span the midcarpal joint due either to extreme laxity or secondary to trauma. The authors, however, did not agree on an anatomical abnormality that might be responsible for midcarpal instability. As a provocation test, they undertook forced dorsal displacement and showed subluxation between the capitate and the lunate, accompanied by pain or apprehension, as one of the abnormal findings.\(^1,4\) Those wrists which demonstrated subluxation of the capitate dorsally from the lunate fossa, even by more than half the width of its head, were normal and asympto-
matic. A lax capitolunate joint must be differentiated from ligamentous insufficiency associated with mechanical symptoms.

The radiolunate joint also showed different responses to dorsal stress. The normal response of this joint to such loading was divided into three distinct patterns. When the lunate displaced dorsally from the lunate fossa of the radius, and the capitolunate joint appeared to be stable (type III), the laxity on dorsal stress was located mainly at the radiocarpal joint. By contrast, when the lunate only extended but did not sublux (type I), dorsal subluxation of the capitate was obvious. When attempts were made to trace the movements of the scaphoid and triquetrum in this type, although these were not clearly outlined in the lateral view, they also tended to follow the capitate. In this type, it can be assumed that the main laxity is around the lunate and represents a perilunar pattern of laxity. This is consistent with the findings of Schernberg who observed the dorsal stress view of the lax joint. In type-II wrists, the laxity on dorsal stress is located at both the capitolunate and radiolunate joints.

Normal subluxation of the capitate, in response to a dorsal or volar stress, can be explained by the anatomical features of the carpal ligaments. The capitolunate joint is known to be unstable. Although the arcuate ligament serves as the primary stabiliser of the distal on the proximal carpal row, there are no longitudinally orientated ligaments between the lunate and the capitate. The perilunar area is a vulnerable zone in most carpal fractures and dislocations. The capitate easily dislocates out of the lunate fossa when the lunate extends, and migrates dorsally from the lunar concavity in perilunar instability.

Our study has shown that about 10% of normal radiolunate joints have an inherent laxity which is represented by subluxation between the lunate and the distal radius rather than lunate extension on dorsal stress. In these wrists, capitolunate or perilunar laxity is unremarkable. For stability of the radiolunate joint, the volar radiocarpal ligaments, which are generally shorter and stronger than the dorsal radiocarpal ligament, may play a major role. Our study has also shown that, in some wrists, the volar radiocarpal ligaments have enough laxity to allow dorsal subluxation of the proximal carpal row when under dorsal stress.

When subjected to a dorsal stress, the patterns of laxity are not uniform and the dominant laxity is found at either the capitolunate or the radiolunate joint. Variable patterns of laxity may in part be a reflection of individual variation in the ligaments of each wrist and also due to the configuration of the articulations. It is clear that the degree of displacement seen on the dorsal stress view does not represent a pathological condition of the ligaments, although pain associated with the test should be regarded as
significant.\textsuperscript{2-4} If asymmetry between the two sides is found on the stress view with associated pain on the affected side, instability due to ligamentous insufficiency may be diagnosed. In this situation, the patterns observed in our study would assist in locating the site of insufficiency by comparing the two sides.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

References


