Dynamic Chiropractic

REHAB / RECOVERY / PHYSIOTHERAPY

Are the Movements of the Wrist and Hand during Normal Physiologic Actions Simple or Complicated?

WHAT DO YOU THINK?

The motions of the wrist, radioulnar, radiocarpal, ulnomenisco-triquetral joints and the remainder of the carpals/metacarpals are indeed complicated. They are coupled with and interdependent upon middle radioulnar and the elbow joint complex having full and normal functions. Their dysfunction can manifest as many conditions that we see in our offices each and every day: carpal tunnel syndrome; ulnar tunnel syndrome; common flexor and or extensor tendonitis; little leaguer's elbow; loss of all or some of the normal ROM/coupled joint-play actions; loss of strength or fine motor control; and a plethora of documented syndromes and joint subluxations within the elbow, wrist and hand.

The action of the carpals during the normal physiological actions of flexion and extension are all coupled motions, that is to say, they all have actions that are dependent upon other actions and therefore a loss of one plane will have an impact on the original coupled action. The hand has often been described as having a stable or rigid portion (the second and third metacarpals and their associated carpal articulations), and a adaptable or flexible portion (the fourth and fifth metacarpals and their associated carpals). The movements that a carpal participates in are dependent upon the previously stated coupled motions, but far more important is the shape of its articular facet facings, i.e., concave, convex, or linear in orientation.

Normal physiological motions of any articulation is determined by its facet orientation with respect to the adjacent articulation, and unless the "norms" are well known, it is indeed very difficult to understand, locate, or treat the patient's abnormal coupled articular complaint. The capitate is the most stable carpal as it articulates with seven other bones and from its center radiates a host of ligamentous structures, carpo-metacarpal, intercarpal and interosseous ligaments. The significance of this stability will be obvious later in this discussion.

Fixed and Mobile Elements of the Hand and Wrist

For functional and examination purposes it is convenient to divide the hand into two parts; fixed or rigid, and mobile or adaptable components. The fixed components include the distal row of carpals and the second and third metacarpals. This component allows some degree of independence, sufficient to permit and insure a discrete but obvious suppleness, yet guaranteeing stability without total rigidity. The mobile portion includes the phalanges, the peripheral metacarpals, essentially the thumb and the fifth metacarpal.

The Arches of the Hand

The thumb and the other four digits form four oblique arches of opposition. The most useful and most functionally important arch is between the thumb and the index finger (used for precision grip). The arch between the thumb and little finger insures a locking mechanism on the ulnar side of the hand in power grip. There are also longitudinal arches and transverse arches.

The Transverse Arches

The carpal arch has a deep palmar concavity which resembles a rigid osseous mass and is often incorrectly termed the "carpal block." Two classifications are useful in the understanding of carpal motion and stability.

1. The horizontal classification stresses the transverse cohesiveness of a bone to bone relationship. The two rows of carpal bones are considered. The proximal row is intercalated between the radius and the distal row. It relates simultaneously to the articular surfaces of both the radius and second carpal row and must constantly adapt to these mobile surfaces.

2. The vertical classification emphasizes the longitudinal coherence, essential for the transmission of muscular forces. Only the radial (scaphoid) and central (capitate articulated with the lunate) columns articulate with the radius. In the ulnar column there is a gap between the ulna and the triquetrum.

The proximal row of carpals is mobile because of its connections to the radius and the distal row. Moreover, the scaphoid, lunate, and triquetrum have their own distinct and specific coupled actions. The scaphoid, as it cradles the capitate, also articulates distally with the trapezium and the trapezoid and so contributes to the stability of the mid-carpal joint.
The transverse arch of the distal row is much more rigid. The keystone of this arch is formed by the capitate, which moves with the fixed metacarpals.

The wrist is more stable in flexion than in extension. This stability is due not so much to the interlocking of the various carpals as to the strength of the various capsules and ligaments (see further in this paper).

The Flexor Retinaculum

The flexor retinaculum distal to the radiocarpal joint forms a roof over the carpal gutter and transforms it into a tunnel. A point worth noting is that the flexor retinaculum has little or no effect on the stability of the wrist, they do however have a function that is by no means insignificant. The extremely strong flexor tendons of the fingers are retained close to the axes of flexion-extension and radial-ulnar deviation by the flexor retinaculum. Due to this unique arrangement the flexors are able to generate almost no torque at the radiocarpal joint while acting upon the digits.

The Metacarpal Arch

The metacarpal arch, in contrast to the carpal arch, is blessed with an abundance of adaptability because of the mobility of the peripheral (those metacarpals on either side of the middle metacarpals) metacarpals. The peripheral metacarpals, one and five, form the sides of the palmar gutter and can increase the depth of the gutter as they approach each other during the coupled motions of flexion and rotation. The thumb metacarpal is separate as it articulates with the trapezium and the middle metacarpals are connected to the carpals by the intrinsic interlocking encasement mechanism of the facet facings themselves, a type of self-locking mechanism. Mobility of the metacarpals with the deep gutter formed:

- The index metacarpal is the most firmly fixed.
- The fourth metacarpal is to be considered a transitional component to the fifth metacarpal and has approximately 10 degrees of mobility in flexion and extension.
- The fifth metacarpal is semi-independent; it articulates with the hamate and is restrained on its radial side by its articulation with the base of the fourth metacarpal.
- The second to fifth metacarpals are bound together by the various fibrous structures; the

most distal is the deep transverse intermetacarpal ligament, also known as the interglenoid ligament. This ligament ties together the anterior "glenoid ligaments" of the metacarpophalangeal joints, known as the volar plates.

The Volar Plates

The volar plates function is prevention of the action known as hyperextension and to increase the distance between the flexor tendons and the axis of the joint and directly improve the efficiency of the flexor groups.

The Longitudinal Arches

The longitudinal arches are composed of a fixed portion, the carpometacarpal, and a mobile portion, the digits. For every ray there is a longitudinal arch. They diverge distally according to different obliquities, the thumb ray being the most divergent. The keystone of these arches are the metacarpophalangeal articulations, whose thick anterior glenoid capsules, the volar plates, prevent hyperextension. The stability of the metacarpophalangeal joint is essential to the support of the longitudinal arch as well as of the transverse metacarpal arch.

The stability of the hand is a complex and highly interdependent action upon the bone segments and the transverse and longitudinal arches. Each of the five rays contains three segments, which are mobile within certain parameters. To stabilize one of these requires three supports-two collateral ligaments and one volar plate for each joint, which means 45 stays for the five rays.

The volar plates reinforce the capsules anteriorly; its thickness increases the distance between the flexor tendons and the axis of the joint, thus improving the efficiency of the flexors, but the main function is to prevent hyperextension. The volar plate limits extension in the proximal interphalangeal joint more than in other digital joints.

At this point a review of the coupled aspects of one articulation moving on another need to be reviewed. The movement of any bone occurring simultaneously around more than one axis and in more than one plane is called coupled motion. An example that most of the DCs will be familiar with is the combination or coupled actions of the spinal segmental motion of lateral flexion. It occurs on a sagittal axis, a frontal plane, a vertical axis and on a transverse plane. These motions occur either passively or actively and are representative of the normal physiological motions of everyday life. This is an interesting reality when one considers the very static one plane nature of uncoupled adjustive procedures and conjures up the question, "Why are not all adjustments given as coupled motion reduction adjustments?"

Rolling actions occur when two points, one on each of the joint surfaces in question, come into contact with each other. Rolling can and does occur between concave and convex partners, i.e., the moving partner being convex and rolling on the stationary concave partner, and the concave partner rolling on the stationary convex surface. The atlas-occiput is a very good example of this, as well as most of the carpals and metacarpals. It is worth noting that if only rolling took place while we were attempting to perform normal physiologic motions, then joint damage in the form of compression would occur, most likely on the same side as the motion was being performed.

Gliding occurs when one point on a moving surface comes into contact with other points on another surface that is not moving, and is best on congruent surfaces. Since there are no contiguous and truly congruent surfaces in the human body, it is highly unlikely that pure gliding actually takes place.

Roll-gliding is a combination of the above two actions and is best on incongruent and curved surfaces. Obvious to all is that the human frame is full of incongruent articular surfaces, i.e., the radiocarpal-metacarpal articulations are but one fine example of this roll-glide action. With respect to which action is the greatest, the general rule of thumb is that the congruency is in favor of the gliding component rather than the roll aspect. Clinically this means that a decrease in the glide component of the coupled joint-motion will have significant effects on all other components of joint motion, i.e., if the distal radioulnar joint is fixed in glide then motions at the radiocarpal and ulnomeniscotriquetral joints will demonstrate coupled motion dysfunction as well.

Direction of rolling and gliding: The rolling partner of the coupled roll-glide action is always in the same direction as the movement of the bone, regardless of whether or not it is the concavity moving on the convexity or the convexity moving on the concavity. It is a good idea to recall that rolling rarely if ever occurs as a pure motion; when adjusting a joint, rolling motions are never used alone, but always as a component of coupled motions. The gliding partner is dependent upon the concave-convex relationship. If the concave portion is moving on the convex member, then joint gliding and bone movement are in the same direction, and the axis of rotation is in the stationery partner. However, if the convex portion is moving on the concave member, then joint gliding and bone movement are in the opposite directions, and the moving bone and its convex articular surface are on the opposite sides of the axis of rotation.

The actions of flexion and extension are significantly coupled and need to be understood with intimate detail. When the wrist is flexed the following coupled motions occur simultaneously:

1. Ulnar deviation is an action that occurs at the radiocarpal joint. It is critical that one understands that ulnar and radial deviation are actions that occur at the radiocarpal joint and not at the ulnar side. Recall from biomechanics that the ulna does not articulate with the triquetrum, rather it articulates with the triangular fibrocartilaginous disc.

2. Flexion occurs 55 degrees at the midcarpal joint, and 35 degrees at the radio-carpal joint, however, this classification of motion is clearly inadequate as it does not take into consideration the vast amount of palmar and dorsal movement of individual carpals. Extension is the reverse of these action.

3. The triquetrum (and pisiform), hamate, lunate, ulnar one-half of the scaphoid (on an oblique axis), and to a significantly lesser extent the capitate, all move as coupled motions in a palmar direction. This palmar oriented coupled motion is the adaptive (conforming to an object or task) component of the hand.

4. The trapezium, trapezoid, and the radial one-half of the scaphoid move as coupled motions in a dorsal direction, and display much less overall movement, consistent with the stability portion of the hand.

5. The action of extension is exactly the opposite (recall that the radial deviation is a function of the radiocarpal joint).

It's obvious that these actions with their complex and varied coupled motions could undergo fixations at any point along the total excursion distance of any individual bone. The hamate may display normal motion when examined in the neutral position, however, when examined in extension it may dysfunction (fixate/subluxate) and result in the signs and symptoms consistent with the patient's presenting complaint, mechanism of injury and case history. Clinically this means that the joint play/accessory motion examination must be done during a number of actions of flexion (and or extension) or we could miss the coupled motion pattern restriction, a.k.a. abnormal coupling patterns. Recall that the rules for joint play state that the plane of joint play/accessory movement is always 90 degrees to the long axis of the moving partner. In this case the moving partner is undergoing the coupled combination of rolling, gliding and translatory sliding, thus resulting in a joint play/accessory movement plane that is (using the above hamate example) in a palmar to dorsal direction with an oblique plane, formed by the coupled movements from the center of the hamate towards the radius.

The significance of all of the above can best be understood in the following case of a male gymnast who presented with a six month history of wrist pain. The mechanism of injury took place during a standard ring routine and involved a static hang in the false grip position, a pull up with a forward roll and press to handstand. In the transition from the full flexion false grip position to a position of stability, that is halfway between full pronation and supination with engagement of the middle radioulnar joint, he felt a sharp pain at the elbow and immediately aborted the routine. His coach did a quick examination, used ice and sent him to emergency. He received an exam, was x-rayed, given a splint and told to see his regular family physician within three days. He did as instructed and his family MD sent him to physical therapy where he was treated for approximately five months with heat packs, soft tissue work, passive and active range of motion stretches and weight resisted exercise program. All treatment was directed to the painful elbow.

The net result of this entire program was an improvement of approximately 10 percent. What went wrong? Why after six months is the patient still in pain and not participating in his chosen sport? To begin with all treatment had been directed to the elbow joint: the symptomatic area. Interestingly enough the patient was able to tell this and upon presentation he was not interested in treatment until asked to describe the actual mechanism of the injury in his own words (using the jargon peculiar to his sport); then he said, "No one understands what I do or how I do it."

Well someone did, and the examining doctor this time talked to the patient in the language of the sport and they went through the activity in question and talked about the possible mechanisms of injury. The wrist joint moved from a position of full active concentric flexion with coupled motions of the entire common flexor group through full wrist rotation to a position midway between supination and pronation via eccentric loading of the common flexor group and concentric contraction of the common extensor group: causing an abnormal biomechanical coupling between the distal radioulnar and the ulnomenisco-triquetral joint.

The action of supination was decreased by approximately 25 percent, and attempts to force it (with or with out extension) caused an increase in pain. The common flexor group was found to be very short and a point to note is that this alone would be enough to block full supination activity, however a 1b afferent stretch quickly eliminated this as "the" cause.

Recall that the pain was reported at the elbow joint, more specifically, at the radiohumeral joint, that all the treatment was given to the elbow region, and that it failed to improve the condition. Is it possible that the elbow symptomatology was just an expression of abnormal couple motion elsewhere? The answer is unquestionably yes, as there are five joints involved in a loss of supination:

1. proximal radiohumeral joint
2. proximal radioulnar joint
3. physiological middle radioulnar joint
4. distal radioulnar joint
5. ulnomenisco-triquetral joint

In this case the abnormal coupled motion patterning was found to be at the distal radioulnar and ulnomenisco-triquetral joints during the coupled motion activity of wrist flexion (with concentric flexor contraction) rotation from a position of supination to the position of middle radioulnar joint activation and stability. The coupled motion reduction adjustments were given to the radioulnar joint in the position of wrist flexion and ulnar deviation in the palmar to dorsal direction, and utilizing a toggle board as well the common flexor group, was stretched via the 1b afferent route.

The ulnomenisco-triquetral joint was adjusted in a dorsal to palmar direction with active wrist extension and radial deviation, once again on the toggle board. The patient was instructed to ice/heat (contrast packs) and to continue at home with active range-of-motion stretches. He was treated a total of six times (not six months) and returned to his gymnastic career. The patient was seen in a follow-up two times over the next six months, and was asymptomatic with respect to this injury.

As an aside, the coach was impressed and subsequently sent his entire club in for a chiropractic biomechanical evaluation: 36 new patients just because the Dr. new the biomechanics of a particular sport.

Understanding the normal anatomy, the actual coupled-motion joint biomechanics, the kinesiology and biomechanics of the sport, the mechanism of injury followed by the correct coupled motion reduction adjustments, appropriate modalities and specific active rehabilitation exercises made this a very simple case.

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