Hand Span and Digital Motion on the Keyboard: Concerns of Overuse Syndrome in Musicians

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Purpose: To investigate the hand motion of pianists when they performed an octave and a chord, which accounted for 74% of the piano techniques that the subjects practiced at the onset of overuse hand problems. The octave position was to strike 2 keys that were 16.7 cm apart simultaneously with the thumb and small finger, and the chord position was to strike 3 keys with 4.8 cm between the borders.

Methods: The abduction angle of both the thumbs and the small fingers of 10 pianists while playing a chord and an octave were measured repeatedly with a video-based passive marker detection system. The angles were compared between pianists with large hand spans and those with small hand spans.

Results: When playing the octave both the maximal and minimal abduction angles of the thumb were significantly larger for the smaller-hand pianists as compared with the pianists with larger hand spans. When playing the chord the maximal abduction angle of the thumb of small–hand-span pianists was significantly larger than that of large–hand-span pianists. The abduction of the small finger, however, did not differ during performance of either the octave or the chord.

Conclusions: These results suggest that the small–hand-span pianists must abduct the thumb more than large–hand-span pianists while minimizing movement of the small finger. This may cause de Quervain's tenosynovitis in pianists. (J Hand Surg 2006;31A:830–835. Copyright © 2006 by the American Society for Surgery of the Hand.)

Key words: Finger, hand span, keyboard, motion, piano.

Overuse syndromes in musicians have been reported since the end of the 19th century. In 1887 Poore[1] reported on 21 professional instrumentalists with hand difficulties from playing the piano and compared the problem with writer's cramp. He emphasized the effects or benefits of rest as treatment. This led to most of the patients being free from symptoms in the extensor apparatus of the fingers and wrists.

It took another 100 years, however, before hand problems of musicians began to interest physicians. Hochberg et al[2] reported on 100 musicians with medical troubles and reported that 42% had inflammatory disorders such as tendinitis, tenosynovitis, arthritis, and epicondylitis. Forty-two percent of the patients had nerve disorders including entrapment and motor control disorder. Additional difficulties included symptoms of loss of control (34%) diminished facility (18%), endurance (18%), or speed (18%) while playing trills, arpeggios, or an octave requiring fast and forceful finger movements. Lederman and Calabrese[3] classified the overuse syndromes of musicians into 5 categories: (1) those involving bones, joints, and bursae; (2) disorders of the musculotendinous unit; (3) primary muscular pains or cramps; (4) nerve entrapments; and (5) the poorly characterized group collectively known as *occupational palsies*. He stated that overuse syndromes are related to extrinsic factors of the musician's hand technique and environment.

The first author (N.S.) has investigated overuse problems previously[4–6] among Japanese pianists and found that 70 of 200 pianists developed the problem when practicing piano techniques such as octaves

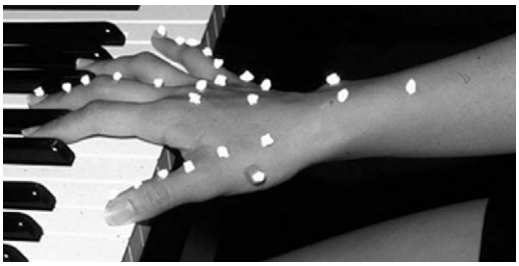

Figure 1. Twenty-six reflective markers, 2 mm in diameter, were placed on the dorsal side of the fingers, hand, and distal forearm for 3-dimensional motion analysis (Expert Vision System).

and chords. The octave and chord techniques accounted for 74% of all cases and were associated with abduction of the thumb and small finger and stabilization of the wrist. Because it is believed that small-handed pianists are obliged to have a greater abduction angle in the thumb and the small finger when playing octaves and chords compared with large-handed pianists, this could cause more overuse in the abductor and extensor muscles of the 2 fingers of small-handed pianists. Because the hand motion during piano playing is too rapid and complicated to be measured, a relationship between the piano-playing techniques and the hand-span changes is not clear.

In this study we measured the abduction angle of the thumb and the small finger of pianists while they were playing by using a video-based passive marker detection system (Expert Vision System; Motion Analysis Corporation, Santa Rosa, CA) that calculates the 3-dimensional position of designated markers on a moving object (in this case the hand and fingers).[7] The pianists with larger hand spans were compared with those with smaller hand sizes to investigate the relationship between the hand span and the abduction angle of the thumb and the small finger. This anatomic and biomechanic difference is suspected to be an important factor in the development of overuse syndromes in pianists.

Materials and Methods

The test subjects were 5 professional or semiprofessional pianists and 5 amateur pianists. There were 4 men and 6 women and the mean age was 29 years (range, 24–39 y). For all 10 subjects we measured the hand span between the tips of the thumb and the small finger. The 10 pianists then were divided into 2 groups based on hand span: 5 with the longest and 5 with the shortest hand spans. The hand span between the thumb and small fingers of the large–hand-span pianist group was an average (±SD) of 24 ± 1.3 cm. The hand span of the small–hand-span group was an average 20 ± 0.6 cm, which was significantly smaller in span than the large-hand-span group ($p < 005$).

The video-based passive marker detection system was used to collect the data. This system consists of 4 video cameras, a video processor (VP 320; Motion Analysis Corp.), and a system that is capable of tracking the motion of reflective markers in 3 dimensions to within an accuracy of 0.1% of error (SUN 4-110; Sun Microsystems, Santa Clara, CA) The computer software was customized to compute rapidly the changing joint angles from the detection marker data generated by the video-tracking system. The calibration of the volume space was performed using a calibration frame that was 40 × 30 × 30 cm. Sixteen reflective markers that were 3.8 cm in diameter each were covered with reflective adhesive tape (3M Company, St. Paul, MN) and used to identify the calibration frame.

White 2-mm plastic beads (Precision Plastic Ball Co., Chicago, IL) were covered with reflective adhesive tape and 26 markers were placed on the dorsal side of the middle finger, small finger, thumb, dorsal hand, and forearm (Fig. 1). Of these 26 markers 8 were used for measuring the abduction angle of the thumb and the small finger. Markers A and B were placed in midline on the dorsal side of the basal phalanx of the thumb (Fig. 2). Marker C was placed on the dorsal side of the distal phalanx and markers G and H were placed on the dorsal side of the basal phalanx of the small finger. Markers D and E were placed on the dorsal side of the metacarpal head of

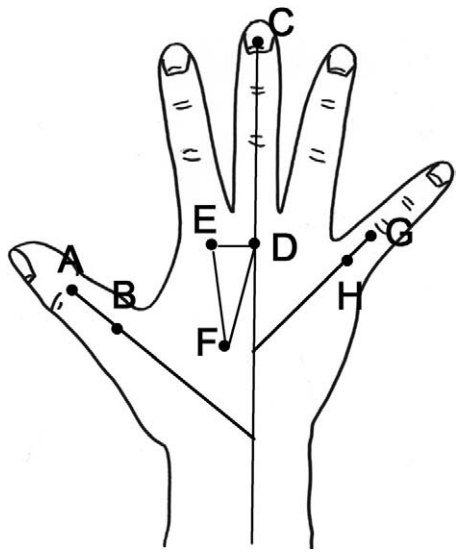

Figure 2. Reflective markers placed on the hand for defining the abduction angles of the thumb and the small finger.