Carpal tunnel syndrome leads to significant bone loss in metacarpal bones

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Abstract The present study was designed to determine bone density modifications at the forearm and metacarpal bones in patients with carpal tunnel syndrome (CTS). Bone mineral density (BMD) was measured by dual-energy X-ray absorptiometry at the one-third distal end and for the total of the radius–ulna, together with the third and fourth metacarpal bones, in 48 clinically and electrophysiologically diagnosed (18 unilateral and 15 bilateral) affected extremities in 33 premenopausal women (mean age 38.9 ± 6.5 years) with CTS. BMD values for non-affected extremities were used as controls for comparison with affected extremities. Bone mass was decreased approximately 7% in the forearm region (P < 0.02) and 18% in metacarpal bones (P < 0.01) of the thenar atrophy associated group compared with controls. A significant correlation was observed between disease duration (mean duration 3.2 ± 2.7 years) and the decrease in metacarpal bone density (r = 0.43; P = 0.004). This is the first clinical report of quantified bone loss in affected extremities in patients with CTS, and the results suggest the need for further studies to assess the clinical significance and morbidity of this pathology, especially in patients with thenar atrophy.

Key words carpal tunnel syndrome · DEXA · bone density · thenar atrophy · metacarpal bones

Introduction

Carpal tunnel syndrome (CTS) is a consequence of chronic median nerve compression at the wrist. The syndrome is common, with an estimated population lifetime cumulative incidence rate of 8%, and it can be associated with substantial disability [1]. The nerve degeneration and muscle weakness leads to thenar atrophy as the disease advances. The muscle atrophy may also lead to bone mass loss in an individual extremity [2–4]. Extensive research efforts have been devoted to bone density studies in osteoporosis because it is now well understood that low bone mass is a predictor of future fractures. The determination of the fracture risk, so as to reduce health care costs and morbidity, is the first step. However, the best assessment of fracture risk at a specific site is made by measuring bone mass at that site [5]. Because muscle (thenar) atrophy is present in advanced cases of CTS, it is questionable whether there is any associated bone loss that may, ultimately, lead to a fragility fracture. It has been reported in one study that, according to radiometric findings, metacarpal bone density was increased in patients with CTS following a ligament-releasing operation [6]. However, neither quantitative bone nor fracture risk assessments have been performed in CTS patients since then. If the release of disease gives rise to an increase in bone density in an affected extremity, then bone loss would, hypothetically, be an expected consequence of CTS, especially in chronic cases.

Thus, the aim of the present study was to investigate forearm and metacarpal bone mineral density (BMD) modifications in CTS.

Materials and Methods

Patients

Over 2 years, 50 consecutive patients (four men, 46 women) with clinically and electrophysiologically diagnosed CTS were enrolled in the study. Of those, four men and 13 postmenopausal women were excluded from the study to allow for a homogeneous study group for BMD comparisons. The remaining patients consisted of 18 unilaterally and 15 bilaterally affected premenopausal women. Of the 66 extremities, 18 were not affected by CTS and 48 were. Affected extremities were...
divided into two groups: thenar atrophy free (TAF; \( n = 34 \)) and a thenar atrophy associated group (TA; \( n = 14 \)). Thenar atrophy was diagnosed by the same experienced neurologist (KT) throughout the study. The diagnosis of thenar atrophy was based on clinical examination (inspection and palpation), in which the main consideration was the observation of the typical appearance of shrinkage (atrophy) of the thenar muscle. All patients underwent BMD measurements at both forearms and hands. The extremities not affected by CTS were defined as the control group, and the regional BMD values of extremities from the TA and TAF groups were compared with the control group. The study was approved by the Ethics Committee of the faculty and informed consent was obtained from all patients.

**Electrophysiologic study**

Conventional median and ulnar nerve conduction studies measuring motor and sensory latencies were performed bilaterally using an electromyography instrument (Neuropack 8, model MEB 4200; Nihon Kohden, Tokyo, Japan) operated by the same physician (KT). In all cases, skin temperature was maintained above 31°C with a heat lamp. Stainless-steel surface disc electrodes with an 8mm diameter were used for recording. Distal motor latency (DML) from wrist to abductor pollicis brevis muscle (APB), motor nerve conduction velocity (NCV) throughout the segment between the elbow and wrist, and sensory NCV from the wrist to the midpalm (stimulation over wrist and recording from digit II, antidromically) for the median nerve were measured. Distal motor latency (DML) from wrist to abductor digiti minimi muscle, motor NCV throughout the segment between the elbow and wrist, and sensory NCV from the wrist to digit V for the ulnar nerve were also measured. Using normal values of our electrophysiology laboratory, CTS was diagnosed if a median DML value was over 4.2msec, and the median sensory NCV value was below 40m/s throughout the wrist–midpalm segment, and the other parameters (median motor NCV, ulnar DML, ulnar motor and sensory NCV) were in the normal range.

**Measurement of BMD**

BMD, expressed as the amount of mineral (g) divided by the area of interest (cm²), was measured by dual energy X-ray absorptiometry (DEXA; QDR 4500W Acclaim; Hologic, Waltham, MA, USA) at the distal third of the radius + ulna, total radius + ulna and at the third and fourth metacarpal bones by the standard array mode of acquisition. The in vitro precision of BMD measurements, according to the coefficient of variation, was 0.36% during the study period.

**Statistical analysis**

Student’s t-test was used for the comparison of age between unilaterally and bilaterally affected patients and for comparison of disease duration between the TA and TAF groups. \( P < 0.05 \) was considered significant.

Each case (affected forearm) was assumed to be an independent variable and group comparisons (control, TAF, TA) for electrophysiologic and BMD measurements were made using one-way analysis of variance (ANOVA). Tukey’s honestly significant difference test was conducted as the post hoc test in the event of statistically significant F ratios \( (P < 0.05) \).

The relationship between metacarpal bone density (as a dependent variable) and the disease duration and age (as independent variables) was examined using multiple stepwise regression analysis. The probability of \( F \) for entry into the model was 0.05.

**Results**

The mean (±SD) age of all cases (unilateral + bilateral) was \( 38.9 ± 6.5 \) years (range 25–52 years), and the mean duration of symptoms was \( 3.2 ± 2.7 \) years (range 0.2–10 years). The mean age of unilaterally and bilaterally affected patients was \( 37.7 ± 6.6 \) and \( 40.5 ± 6.3 \) years, respectively \( (P = 0.08) \). The mean duration of the disease in TA group was longer \( (5.5 ± 2.8 \) years) than that in the TAF group \( (2.6 ± 3.1 \) years; \( P < 0.01 \)). The results of comparisons of the three study groups (control, TA and TAF) for electrophysiologic findings and regional BMD values are summarized in Table 1. The DML and sensory conduction of the median nerve were significantly different among the study groups \( (P < 0.001) \). Multiple comparisons performed by the Tukey test revealed that the DML was significantly different (longer) in the TAF and TA groups than in the control group. The difference was also significant between the TA and TAF groups \( (P < 0.001) \).

Sensory conduction of the median nerve was significantly decreased in the TA and TAF groups \( (P < 0.001) \) compared with controls.

BMD values in individual regions (distal third of the radius + ulna, total radius + ulna and mean of third to fourth metacarpal bones) were significantly different among the study groups \( (P < 0.05) \). Bone mass was diminished by approximately 7% at the distal third of the radius + ulna and total radius + ulna regions in the TA group compared with controls \( (P < 0.02) \). In contrast, the difference in metacarpal BMD was striking between the TA group and both the control \( (P = 0.006) \) and TAF groups \( (P = 0.017) \). The Decrease in BMD in metacarpal bones was approximately 18% in TA hands compared with the control group.