Cystic Radio-Lucency of Carpal Bones in Haemodialysis Patients

An early indicator of the onset of carpal tunnel syndrome

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Patients receiving haemodialysis for more than 10 years were selected for this study in order to clarify an apparent sequential association of cystic lesions of carpal bones and carpal tunnel syndrome. X-rays and computed tomographs of 138 hands of 69 patients revealed cystic radiolucency of carpal bones in 35% of the hands. Radiographs were classified into three groups: Group A—cyst growing, Group B—cyst not growing, and Group C—cyst absent. The prevalence of carpal tunnel syndrome was 100% (27/27) in Group A, 5.6% (1/18) in Group B, and 6.5% (6/93) in Group C. Growth of the cyst precedes the development of carpal tunnel syndrome by about 2 or 3 years. Growth of the bone cyst indicates that inflammation had already extended to the tenosynovium and median nerve. Cystic radiolucency of the carpal bones appears to be a useful indicator of the onset of carpal tunnel syndrome.

Journal of Hand Surgery (British and European Volume, 1994) 19B: 5: 636–637

Prolonged survival of patients in chronic renal failure managed by haemodialysis (HD) has led to the recognition of various osteoarticular and soft tissue complications. The first report of the development of carpal tunnel syndrome (CTS) in dialysis patients was from Warren and Otieno (1975). Since then, CTS is increasingly recognized in such patients. It was proved that the amyloid associated with dialysis was β₂-microglobulin (MG) from tenosynovium (Gejyo et al, 1985) and carpal bone cysts (Casey et al, 1986). The chronic accumulation of β₂-MG in patients in long-term haemodialysis is believed to play a key role in amyloid-associated arthropathy, induction of CTS, and cystic radiolucent lesions of the bones. These lesions were found in the periarticular bones, and at sites of ligamentous insertions in hips, shoulders and wrists (Bardin et al, 1985; Huaux et al, 1985). The cystic lesions of carpal bones are said to be associated with CTS (Fenves et al, 1986; Homma et al, 1992).

The sequential association of cystic lesions of carpal bones and the onset of CTS has not yet been clarified. We analyzed the annual skeletal surveys of carpal bones, and studied the area, location and shapes of cysts, and the relationship between the growth of carpal bone cysts and onset of CTS.

Material and Methods

The skeletal surveys of the 69 patients (138 hands) in long-term haemodialysis that were taken every April for 10 years were studied retrospectively. Some patients with hyperparathyroidism underwent additional periodic hand surveys. There were 43 men and 26 women aged from 34 to 81 years (average 55.6 years) who were treated at Shigei Hospital. The average treatment period of HD was 15.1 years (range from 10 to 21 years). All the patients with CTS had release of the flexor retinaculum, resulting in immediate relief of pain. We reviewed the most recent radiographic skeletal survey of each patient. Doubtful X-rays were supplemented by plain tomography, and computed tomography (CT), for the same 35 cases, and magnetic resonance images (MRI) were obtained for only ten of them. The lesions studied were located on the carpal bones, and distal ends of the radius and ulna.

Total areas of cystic lesions were calculated every year by a digitizer (System Supply Corp. Nagano, Japan. Bone Morphology Calculation System). Radio-lucency of cysts on the radiographs of the hand were classified as follows: Group A—cyst growing; Group B—cyst not growing, and Group C—no cyst. Characteristics of the lesions of cyst formation in the early stage were divided to three types due to cyst radio-lucency visible on X-ray: Type 1—non-sclerotic type, Type 2—periarticular sclerotic type, Type 3—marginal sclerotic type (Fig 1). We studied relationships between cyst development and recognized onset of CTS, type classification, and serum levels of β₂-MG, aluminium, and terminal C parathyroid hormone (PTH-C).

Results

Of the 138 hands, 45 hands (35%) had 85 cystic lesions. The mean number of cysts per hand was 1.9, and the maximum was 5. The number of cysts found in the following bones were: 28 in the scaphoid; 20 in the lunate; 15 in the capitane; three in the trapezium; one in the hamate; one in the triquetrum, and 17 in the radius and ulna. Group A had 27, Group B had 18, Group C had 93 hands. There was no significant difference between the three groups and HD duration, but Group C hands were from significantly younger patients than either Group A or B (p<0.001, Table 1). According to the type classification, Group A induced 19 cysts of Type 1, six of Type 2 and two of Type 3, Group B had six of Type 1, five of Type 2 and seven of Type 3. The non-sclerotic cysts (Type 1) were often seen in Group A, but not always.
CYSTIC RADIO-LUCENCY OF CARPAL BONES

Fig 1  (a) Type 1 (non-sclerotic type). First appearance of cyst. (b) 1 year after first appearance of cyst. (c) Type 2 (peripheral sclerotic type). First appearance of cyst. (d) 1 year after first appearance of cyst. (e) Type 3 (marginal sclerotic type). First appearance of cyst. (f) 7 years after first appearance of cyst.
We confirmed 67 cysts in 32 hands through CT imaging. 45 were open cysts (67%). 21 pericortical cysts, which did not have an open hole on the CT imaging, did have contact with the cortex (32%), and one other pericortical cyst had no contact with cortex. There were 47 cysts (70%) at the volar side, six (9%) at the dorsal side, and 14 (21%) in the centre (Fig 2). MRI of ten hands showed the cysts filled by granulation tissue from the tenosynovium (Fig 3).

CTS was recognized in 34 of the 138 hands (24.6%). The mean period of HD treatment before the onset of CTS was 14.5 ± 3.9 year. The mean period of HD treatment from the first appearance of cyst to onset of CTS was 4.1 ± 1.72 year. The prevalence of CTS was 100% (27/27) in Group A, 5.6% (1/18) in Group B, and 6.5% (6/93) in Group C. The incidence of CTS in Group A was significantly higher than Group B and Group C (P < 0.001; Table 2). Cyst growth rate increased sharply just before the point at which CTS could be diagnosed. In Group A, 22 hands out of 27 (81%) that had achieved a growth rate over 15 mm² per year or over 200% more than the previous year, developed CTS within 2 or 3 years from that point, and all cases had CTS within 4 years (Figs 4 and 5). In Group B, one case had CTS, although the cyst was not growing (Fig 6).

Mean serum levels of PTH-C, β₂-MG, and aluminum were shown in Table 3. There were no significant correlations between groups and the serum level of β₂-MG, aluminum, or PTH-C.

DISCUSSION
The pathogenesis of CTS in haemodialysis patients has been discussed in the literature for more than two decades. Previous reports identified a close relationship between CTS and presence of an arteriovenous fistula (Warren and Otieno, 1975; Kenzora, 1978; Halter et al, 1981; Delmez et al, 1982; Bussel et al, 1971). During dialysis, both the venous pressure and the volume of the hand are increased distal to the fistula by venous engorgement (Warren and Otieno, 1975). A high rate of blood flow may cause increased venous pressure and engorgement of the synovium and median nerve within the carpal tunnel (Delmez et al, 1982). A high rate of blood flow may also lead to ischaemia within the carpal tunnel, and may predispose it to nerve conduction delay (Bussel et al, 1971). Peripheral neuropathy is commonly seen in chronic renal failure with its associated uraemia (Halter et al, 1981), and the peripheral nerves are
Fig 4 Typical progression of Type 2. Female aged 63 years. Group A-peripheral sclerotic type (Type 2). (a) First appearance of cyst. HD duration was 11 years. (b) 1 year after first appearance of cyst. (c) 2 years after first appearance of cyst. (d) 3 years after first appearance of cyst.

susceptible to minor trauma and to ischaemia (Kenzora, 1978).

Assenat et al (1980) first identified amyloid deposition in the tenosynovium of CTS patients. Gejyo et al (1985) proved that the dialysis-associated amyloid consisted of $\beta_2$-MG from the tenosynovium. The chronic accumulation of $\beta_2$-MG is believed to play a key role in amyloid-associated arthropathy in patients on long-term HD. Tenosynovitis seems to be induced by chronic accumulation of $\beta_2$-MG. Subsequent increased pressure in the carpal tunnel causes the onset of CTS, and although they might increase the severity of CTS, venous pressure, ischaemia, and peripheral neuropathy are not dominant factors. The detailed mechanism of the induction of dialysis-associated amyloid osteoarthropathies is not clear. Perhaps the macrophage infiltration around $\beta_2$-MG is responsible for the inflammation and tissue destruction (Kawai et al, 1992). All of our HD patients had high serum levels of $\beta_2$-MG, but there was no significant correlation between groups and serum levels. Ogawa et al, (1989) also reported that there is a negative correlation between serum levels of $\beta_2$-MG and the presence of dialysis-associated amyloid osteoarthropathies. This shows that factors exist other than chronic accumulation of $\beta_2$-MG.

In this study, there was no significant difference between the presence of cysts and aluminum or PTH-C. Although six patients (nine hands) in Group A underwent parathyroidectomy for hyperparathyroidism, there was no change in their cyst growth rate after surgery. Therefore, PTH-C may be disregarded as a contributing factor.

Yamaguchi et al (1984) reported that cystic radioluencies in the carpal bones in any situation other than haemodialysis or rheumatoid arthritis were found in nine out of 461 hands (1.89%). In HD patients, the frequency of these lesions is higher. Herve et al (1985) reported 9.7%, Laurent et al (1988) reported 25.4%,
Recognized Onset of CTS

Fig. 5 Relationship between cyst growth and onset of CTS in Group A. Cyst growth rate increased sharply (>15 mm² per year) just before the point at which CTS could be diagnosed. 22 hands out of 27 (81%) developed CTS within 2 or 3 years after growth acceleration, and all cases had CTS within 4 years.

Fig. 6 Cyst change in Group B. *One case with CTS.

Table 3—Mean serum level of PTH-C, β2-MG, and aluminum. There were no significant correlations between groups and the serum level of β2-MG, aluminum, or PTH-C

<table>
<thead>
<tr>
<th>Group</th>
<th>PTH-C (ng/ml)</th>
<th>β2-MG (μg/l)</th>
<th>Aluminum (μg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>6.7 ± 11.2</td>
<td>44.3 ± 9.6</td>
<td>13.4 ± 11.7</td>
</tr>
<tr>
<td>B</td>
<td>7.4 ± 5.4</td>
<td>37.1 ± 10.5</td>
<td>10.5 ± 6.9</td>
</tr>
<tr>
<td>C</td>
<td>4.7 ± 6.1</td>
<td>39.7 ± 9.6</td>
<td>12.2 ± 9.2</td>
</tr>
</tbody>
</table>

(mean ± SD)

Sargent et al (1989) reported 36%, and we found 35%. Because of osteoporosis or overlap of bones, it was difficult to analyze the presence of the cyst from a single radiograph (Homma et al, 1992). We used annual skeletal surveys to compare cyst development in our study. Ganglion cysts had sclerotic margins according to Kobayashi et al (1989), and cysts due to HD amyloidosis were described as clear cysts, which we defined as Type 1 (non-sclerotic type). Our examination of the skeletal surveys revealed two other types of cyst formation in their early stages, Type 2 (peripheral sclerotic type), and Type 3 (marginal sclerotic type). In our classification, Type 1 indicates that the bone erosion is progressing, but bone reaction is not visible, Type 2 indicates that a zone of bone synthesis has formed against the bone erosion, and Type 3 indicates a static state. The marginal sclerotic type was rarely seen in Group A. It was sometimes difficult to judge the characteristics of a cyst in the early stage, but the marginal-sclerotic type may have a low rate of cyst growth.

Ogawa et al (1989) reported that the cystic lesions interconnected with the joint space on tomograms, and the histological examination showed inflammatory fibrous granulation tissue in the lesions. We agree with his conclusion that synovitis and the subsequent chronic inflammation were responsible for cyst formation (Fig 3). In our investigation, 70% of the cysts were located on the volar side, and 9% dorsal. This may reflect the confinement of tenosynovium within the carpal tunnel, which is not the case dorsally. The bone cyst might be formed by synovitis and subsequent chronic inflammation.

A relationship between osteolytic lesions of carpal bones and CTS was reported first by Fenves et al (1986). They reported that six out of seven long-term HD patients with CTS showed cystic radio-lucency of the carpal bones. Homma et al (1992) classified the severity of carpal bone cyst into four Grades; Grade 1 with no cyst, Grade 2 with an unclear cyst, Grade 3 with one clear cyst, Grade 4 with at least two clear cysts. They reported that 20 (76.9%) out of 26 patients with CTS showed positive cystic lesions, and the presence of CTS was significantly higher in the most severe cyst grade.

We focused on the hands rather than the patients to clarify the direct relationship with onset of CTS and carpal bone cyst. In our study, all of 27 hands in Group A had CTS. The presence of cysts preceded the recognized onset of CTS which developed after 2 or 3 years. The rate of bone cyst growth was not steady, and accelerated markedly just prior to the point at which it could be diagnosed as CTS according to current criteria. In Group A, onset of CTS was predictable. The presence of a growing cyst indicated that inflammation had already extended to the tenosynovium and median nerve. CTS in HD patients appears to be compounded by peripheral neuropathy caused by such conditions as chronic uraemia (Hallet, 1981), radial artery steal syndrome (Bussel, 1971), and cervical spondylosis (Kuntz, 1984). However, the presence of growing cysts in the carpal bones appears to be useful as an early indicator of the onset of CTS.

Acknowledgement

The authors would like to thank Dr Shohi Kim, Department of Public Health, for his help with the statistical analysis.
References


