Accidental Acroosteolysis

Report of 31 Cases

Association of Occupational Acroosteolysis

The CORUNDA

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chloride and polyvinyl chloride manufacturing processes, is somewhat different from that found in familial osteoporosis with acroosteolysis and in familial osteosclerosis with acroosteolysis. In osteoporosis with acroosteolysis there may be compression fractures in the spine, and basilar impression of the skull, along with destruction of the midphalanges. None of these findings have been seen in these workers. The changes in the distal phalanges are similar in both conditions.

Osteosclerosis acroosteolysis observed by Andren et al (University Hospital, Malmo, Sweden) in twins showed diffuse sclerosis, with cortical thickening of the shafts of the long bones and clubbing of the metaphyseal ends. The phalanges of the hands and metacarpals were foreshortened, and the distal phalanges showed acroosteolytic changes. The feet showed the same changes, except that the distal phalanges were not fragmented.

There has been no evident destruction in the mid or proximal phalanges of the thumbs or fingers of these individuals and no evidence of a lytic, destructive lesion in the feet.

We have not observed any loss of calcium salt in the bones of the wrist and remaining bones of the hand and phalanges in any of these individuals, and there has been no evident sclerosis of the wrist and hand bones.

2. Mild stage: The earliest change found in acroosteolysis in these workers has been a loss of the cortex of one or more of the tufts of the distal phalanges, with no destruction of the tuft or shaft of the distal phalanx.

The next more advanced stage may be a small, half-moon cut in the cortex of the tuft of one or more

### Table 1—Summary of Symptoms and Findings

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>No. of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acroosteolysis without</td>
<td>4</td>
</tr>
<tr>
<td>Basilar impression syndrome</td>
<td>5</td>
</tr>
<tr>
<td>Affected phalanges</td>
<td>5</td>
</tr>
<tr>
<td>Basilar impression sym. and hand</td>
<td>17</td>
</tr>
<tr>
<td>Total</td>
<td>31</td>
</tr>
<tr>
<td>Closing of fingers</td>
<td>8</td>
</tr>
<tr>
<td>Skin nodules</td>
<td>9</td>
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</tbody>
</table>
distal phalanges, or a so-called slice effect along one or more of the tufts. Figure 2 illustrates the small, half-moon cut in the cortex of the distal phalanx of the mid-finger.

3. Advanced stage: A more severe lytic destruction may be a complete loss of the tuft and a portion of the shaft of one or more distal phalanges as illustrated in Fig. 1 in which the tuft of the distal phalanx of the right thumb and the tuft of the distal phalanx of the left fifth finger are completely absent. Additionally, there may be in the same hand a portion of the distal rim of the tuft remaining, with loss of the proximal portion of the tuft and a portion of the shaft of the phalanx, which can also be identified in the remaining phalanges in Fig. 1. This loss may be of a transverse nature through the shaft and the tuft, or of an oblique type loss of bone structure.

4. Healing stage: In this phase, there is often definite fragmentation of the remaining tuft and of the filled-in area where the previous destruction was noted through the shaft of the distal phalanx. This may go on to a complete bony union or remain as a fibrous union with fragmentation. In Fig. 3 and 4, x-ray films of the same individual well demonstrate this. This employed had almost complete union of the multiple fragments when first seen in November 1965 and again in November 1966 (Fig. 3). In the latter, the completely healed shafts and tufts of the distal phalanges are indicated by no residual fragmentation with fibrous union. There is a definite shortening of the shaft and a widening of

the shaft and tuft, both in the transverse and the anteroposterior diameter. This is most likely due to a combination of constant pressure and by the normal tension of the soft tissues, particularly the tendons to the distal phalanges.

Occupational Aspects of Syndrome

Based upon our observations of these 31 cases, it appears as if this syndrome may be of occupational origin and is somehow related to the process of vinyl chloride polymerization. Its specific cause if not presently known. We are performing extensive research in an effort to find the cause. Two other papers referring to the condition have appeared in the literature. The publication by Suciu et al contains no specific information and merely alludes to some hand problem. That of Cordier et al presents case histories with symptoms similar to many of the cases we describe. This syndrome differs from idiopathic and familial acroosteolysis in that only the hands are involved.

Vinyl Chloride Polymerization Process

Polyvinyl chloride is a widely used synthetic resin. It has been manufactured commercially for more than 30 years and is used in upholstery fabric, floor and wall tile, wire insulation, phonograph records, and many other commonly used commodities. For many of these uses, the resin (CH=CHCl), is mixed with other materials to achieve the desired physical characteristics. The hand syndrome occurs apparently only in those people exposed to vinyl chloride or to other chemicals used in the manufacturing process of the resin itself or both. In addition to our examinations of 3,000 personnel performing vinyl chloride manufacturing and polymerization, we have examined more than 1,000 individuals who handle the finished resin or who process it into plastic products. No cases of acroosteolysis have been found in these 1,000 persons.

Basically, the manufacture of polyvinyl chloride consists of polymerizing vinyl chloride. The reaction is accomplished in closed containers (polymerizers) with suitable catalysts and emulsifiers.

Copolymers, formed by combining vinyl chloride with other monomers, create variations of the homopolymer. These are commercially produced. Following polymerization, the resin is washed, dried, and sold as a finely divided white powder.

The polymerization operations are carried out in closed processes and provide little opportunity for employee exposure. Following the completion of the polymerization reaction, periodic cleaning of the walls and agitator of the polymerizer is necessary. The frequency of this cleaning and its method varies with the type of material used in these vessels and with different manufacturers. The most common practice has been to accomplish the cleaning manually by using hand scraping techniques, with workers spending several hours each day on this job assignment. Personnel performing this job are commonly referred to as "polycleaners."
ACROOSTEOLYSIS—WILSON ET AL

Epidemiology

We have attempted to study the relationship of job history to the occurrence of the disease. Twenty-seven of our 31 cases have either been on the "polycleaner" job assignment at the time the syndrome appeared or have had that assignment at some time in the past. This job assignment is the only one showing any positive correlation with the occurrence of the syndrome.

Attack Rate.—The syndrome has a low attack rate. Our experience indicates it occurs only in less than 3% of all production employees who at one time have had polycleaning experience.

Age Distribution.—The youngest of our cases is 28 years old, and the oldest is 47, with the majority falling in the 30 to 39 age group. The complete distribution is shown in Table 2.

The appearance of the syndrome among younger employees may be influenced by the fact that the polycleaning job is one of the initial job assignments into which employees in such plants are hired.

Incubation Period.—If this syndrome is related to occupational factors, as we believe, then the time of exposure to these factors should be significant. We have investigated the time spent on polycleaning and, although accurate job-time assignment information is difficult to develop, it appears as if none of these cases has had less than 12 months polycleaning experience.

Comment

To our knowledge, this is a unique and, with the exception of references 3 and 4, previously unreported disorder. The specific cause is presently unknown, although it appears to be related to the manufacture of vinyl chloride and polyvinyl chloride. Not only are the x-ray findings of themselves unique, but when accompanied by the symptoms of Raynaud's phenomenon, the syndrome becomes extremely specific. As far as we are aware, this has not been an observed response to any toxicant in any of the animal species. We have attempted to arrive at an explanation of its cause, as well as the physiological mechanism whereby the extreme specificity for the distal phalanges of the hands occurs, but have been unsuccessful. We believe the condition is the result of three factors, all of which must be present for occurrence: (1) a chemical insult, (2) a physical insult, and (3) a personal idiosyncrasy. The chemical insult could occur from one or more of the monomers, catalysts, and intermediate reaction products existing in polymerizers. A low degree of exposure to these could occur from contact with the solid, slightly moist, residue in the polymerizer or to small quantities of vapor, absorbed either percutaneously or by inhalation. Research studies are in progress in an attempt to verify the chemical insult factor theory.

The physical insult is present in all "polycleanin
era" to some degree through the prolonged hand scraping operations as well as the occasional use of hammers to remove the residues. In support of the physical insult factor, we have quite recently observed the effects of a finger injury to an existing case of this syndrome. Figure 4 (left) shows an x-ray film of the left hand of the first of these cases of acroosteolysis (accompanied by Raynaud's symptoms and skin nodules on the dorsal surfaces of the hands). The bone damage is quite limited. Figure 4 (right) shows the same hand with the roentgenogram taken four months after a crushing injury to the mid finger, with lysis having resulted to the tuft of the distal phalanx. We believe this activity was stimulated by the trauma.

Personal idiosyncrasy appears to be an important factor because of the low incidence of occurrence of the disorder. This is especially significant because, although all polycleaners are subjected to essentially similar chemical and physical insults, the incidence of this syndrome is very low, and the explanation for this can only be made on the basis of personal idiosyncrasy. We suspect pertinent factors here are related to the individual's vascular system, the nerves controlling the blood supply to the fingers, and to the specific type of collagen in the individual's hands. We are in the process of investigating these factors.

We have observed no serious disability in any of these cases. A few have been partially disabled because of hand soreness, to the extent that some restriction in manual activity was necessary. Improvement in the symptoms, as well as in the roentgenological findings, has occurred in many cases without adequate explanation.

We wish to emphasize that no cases have been found, after extensive search, in individuals either working with the finished polyvinyl chloride or its copolymers, or in processing the polymer into plastic products. In these processes, more exposure to the polymer occurs than does in the manufacturing of the polymers themselves.

We presently believe that personnel assigned to polycleaning should be evaluated, prior to assignment, for any evidence of collagen disease, osteo-

yses of the hands, or abnormal response of the hands to cold insult. Any evidence of the existence of any of these factors should contraindicate the assignment of an individual to "polycleaning," and thus remove, or at least minimize, the personal idio-
synracy factor.

References


