Skeletal Pathology of Prehistoric Human Remains from Crescent Beach

OWEN B. BEATTIE

Introduction

Crescent Beach (DgRr 1) is an extensive midden site located on the eastern shore of Boundary Bay, fifteen miles south of Vancouver, B.C. (Fig. 88). During March of 1972 an extensive archaeological salvage project was conducted under the direction of R.C.W. Percy with a crew consisting of archaeology students and enthusiasts from Simon Fraser University, Douglas College, the Archaeological Society of British Columbia, and the B.C. Provincial Museum. Over 1300 artifacts and 18 human burials were recovered from the excavations, while at least 200 more artifacts and the remnants of an as yet undetermined number of individuals were collected from disturbed cultural deposits surrounding the excavations (Percy 1972b).

Analysis of the cultural material has recently been completed by Percy (1974), and a preliminary osteometric analysis of the human material is on file at the Simon Fraser University Museum of Archaeology and Ethnology (Beattie 1974a). The present report is concerned with concisely describing and diagnosing the skeletal pathology present in the 18 human burials recovered from the controlled excavations.

Twelve of the eighteen burials were either undisturbed or stratigraphically located immediately after discovery. This made it possible to accurately establish their cultural affiliations. Percy (1974: 271; Table VII) has described the deposits containing the burials as representing three cultural phases:

Crescent Beach I (Mayne Phase)
3400 B.C. – 1100 B.C.
containing burial numbers 12, 13, 15

Crescent Beach II (Locarno Phase)
1100 B.C. – 400 B.C.
containing burial numbers 1,3,4,5,6,7,8,10

Crescent Beach III (Marpole Phase)
400 B.C. – A.D. 400
containing burial number 16

Burials lacking definable stratigraphic context or too disturbed for accurate cultural placement include numbers 2,9,11,14,17,18.

Estimates of sex were made by the evaluation of specific morphological characteristics described by Krogman (1962) and Stewart (1957; 1973). Methods of age estimations varied with the conditions and completeness of the individual burials. Male and female pubic symphyseal age was determined using the standards and epoxy casts of McKern and Stewart (1957) and Gilbert and McKern (1973). Epiphyseal union of the post-cranial skeleton (McKern and Stewart 1957; Stewart 1973) and eruption of the permanent dentition were also used. Ectocranial suture closure has been shown to be very unreliable as an age indicator (Singer 1953; Brooks 1955; McKern and Stewart 1957), especially for females. Age estimates utilizing this method were made only in the absence of more reliable indicators. Table 1 contains the sex and age estimates for the material.

Skeletal Pathology

A number of pathological conditions occur in the material and these are described below.

Degenerative Arthritic Changes

Degenerative joint disease is the most common pathological form present in the sample. Out of the

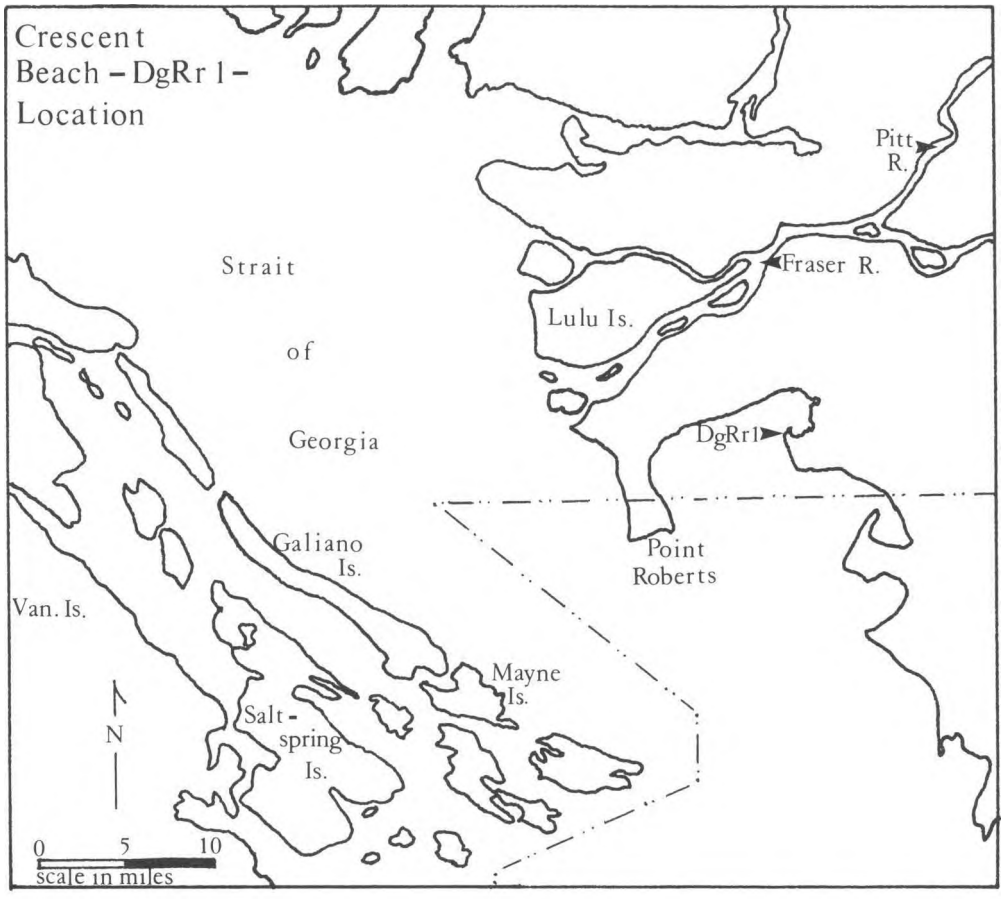


Fig. 88. Map showing location of DgRr 1.

18 recovered burials, 14 are complete enough to make relatively complete pathological evaluations (burial numbers 1–8,10,13,15–18), and 10 (71.4%) of these display varying degrees of degenerative changes involving the joint surfaces of the appendicular and axial skeleton.

Osteoarthritis: This is a degenerative disease that is primarily an expression of the aging process. In diarthrodial joints it is characterized by a bony lipping around the joint margin and is often accompanied by a roughening, pitting, and rarefaction of the articular bone surface. The presence of osteoarthritis in a majority of the DgRr 1 burials reflects their adult to old-adult status. Slight to moderate lipping and pitting of a majority of the appendicular articular surfaces were noted for burial numbers 1,2,5,10,13, and 16. Severe lipping and pitting occurs in burial 5. Apophyseal joint surfaces are degenerated in burial numbers 2 and 5, and the auricular surfaces of both innominates from burial 13 show nodular degenerative changes.

Rheumatoid Arthritis: This disease occurs primarily in women (3:1 over men) between the ages of twenty to forty, afflicting the cartilages of the small joints in the hands and feet as well as the larger joints during its more advanced stages (Bourke 1967). Burial 4 (a twenty-five year old female) is represented by a fairly complete skeleton. Degenerative arthritic changes are widespread and certain areas, such as the patellae, the lunates, left capitate, phalanges, and the apophyseal and costovertebral joints, show severe pitting, bone resorption, and localized sclerosis. Thoracic vertebrae 8 and 9 are ankylosed. Rheumatoid arthritis *may* be the pathological agent involved here.

Ankylosing Spondylitis: This condition (also referred to as Marie-Strümpell disease) is a chronic and progressive inflammatory joint disease of unknown etiology that affects males over females by a ratio of 9:1 (Huskisson and Hart 1973; Sissons 1966). Age at onset is usually early, though variable between 15 and

Table 1. Age and sex of Crescent Beach skeletons

Burial Number	Sex	Age	Cultural Affiliation at Crescent Beach
1	Male	Old Adult	II
2	Male	Old Adult	?
3	Male	Adult	II
4	Female	Adult	II
5	Male	Old Adult	II
6	Male	Adult	II
7	Female	Young Adult	II
8	Male	Old Adult	II
9	Female	Adult	?
10	Male	Old Adult	II
11	Female	Adult	?
12	?	Adult	I
13	Female	Adult	I
14	?	?	?
15	Female	Adult	I
16	Female	Adult	III
17	Male	Young Adult	?
18	Female	Adult	?

30 years of age. The sacro-iliac joints are first affected, almost always bilaterally, and involvement of the spine occurs from this region upward. The disease is distinguished by progressive ossification of the spinal ligaments and degeneration of the synovial joint spaces resulting ultimately in bony ankylosis. Inflammation and degeneration of the peripheral joints is a frequent occurrence, though not the rule. Advanced stages of the disease involve ossification of the annulus fibrosus and, less frequently, the nucleus pulposus (Sissons 1966; Boland 1966). Restriction of body movement in these advanced stages and the rigidity of the spine greatly increases susceptibility to vertebral fracture through trauma (Good 1967). Other features of the disease in modern populations include aortic valve lesions (4–5%), iritis (25%) often leading to blindness, and widespread generalized disuse osteoporosis (Boyd 1961; Jaffe 1972; Nordin 1973).

The fragmentary and very friable remains of burial 8 display massive degenerative changes that describe a classic case of advanced ankylosing spondylitis. In the vertebral column the atlas is fused to the skull by ossification of the apophyseal joints and the anterior and posterior atlanto-occipital membranes. The transverse ligament has also begun to ossify. Vertebral fusion is complete from the axis to the fifth cervical (Fig. 89), anteriorly by syndesmophyte formation and bridging, and posteriorly by the ossified posterior longitudinal ligament, the ligamenta flava, and the apophyseal joints. Cervicals 6 and 7, though separate, have very degenerated apophyseal joints with much bone resorption. The dens of the axis is expanded into a mushroom shape and is highly porous (Fig. 89). The cervical vertebrae still retain their secondary curvature. There are no osteophytes on the vertebrae and the anterior longitudinal ligament has not ossified.

The ninth thoracic down to the fourth lumbar vertebrae are all fused into a single unit by ossification of the ligamenta flava, apophyseal joints, and interspinous ligaments. All of the transverse processes have been broken away post-mortem, though some rib fragments show definite costovertebral fusion. In this fused spinal segment, only the body of thoracic 11 and parts of thoracic 12 and lumbars 1–3 are present. The bodies of lumbars 1–3 are compressed anteriorly, forming a severe lumbar kyphosis approaching 90^{o} (Fig. 90). The anterior and posterior longitudinal ligaments are not ossified. However, the annulus fibrosus and nucleus pulposis of a number of

Fig. 89.
Fused cervicals 2–5.

intervertebral discs have undergone ossification, forming nodular spicules of bone in the centre and around the periphery of the observable vertebral bodies. Some bodies are fused by these exostoses.

The thoracic column is noticeably rotated to the left and may well represent the only direction from which this individual could look upward. The column is broken post-mortem above thoracic 9 and below lumbar 4. The loss of the innominates through disintegration in the ground and the extremely fragmentary nature of the sacrum have made any observations of the sacro-iliac articulations impossible.

Other bones showing severe degenerative changes of the articular surfaces in burial 8 are the scapulae, right humerus, right clavicle (Fig. 91), carpals, metacarpals, ribs, right femur, tibiae, metatarsals, and phalanges. The lateral half of the left mandibular condyle is heavily pitted, though there is no involvement of the left mandibular fossa or articular tubercle, indicating inflammation only of the inferior compartment of the temporomandibular joint.

Disuse atrophy has greatly affected the constitution of the bone in this individual. The disabling effect of the disease has produced a severe osteoporosis in most or all of the skeleton (Fig. 92), probably contributing to the collapse of lumbars 1–3. The outer cortex of many bones, especially in those areas where there are no muscular, ligamentous, or tendinous attachments, has been resorbed leaving a trabecu-

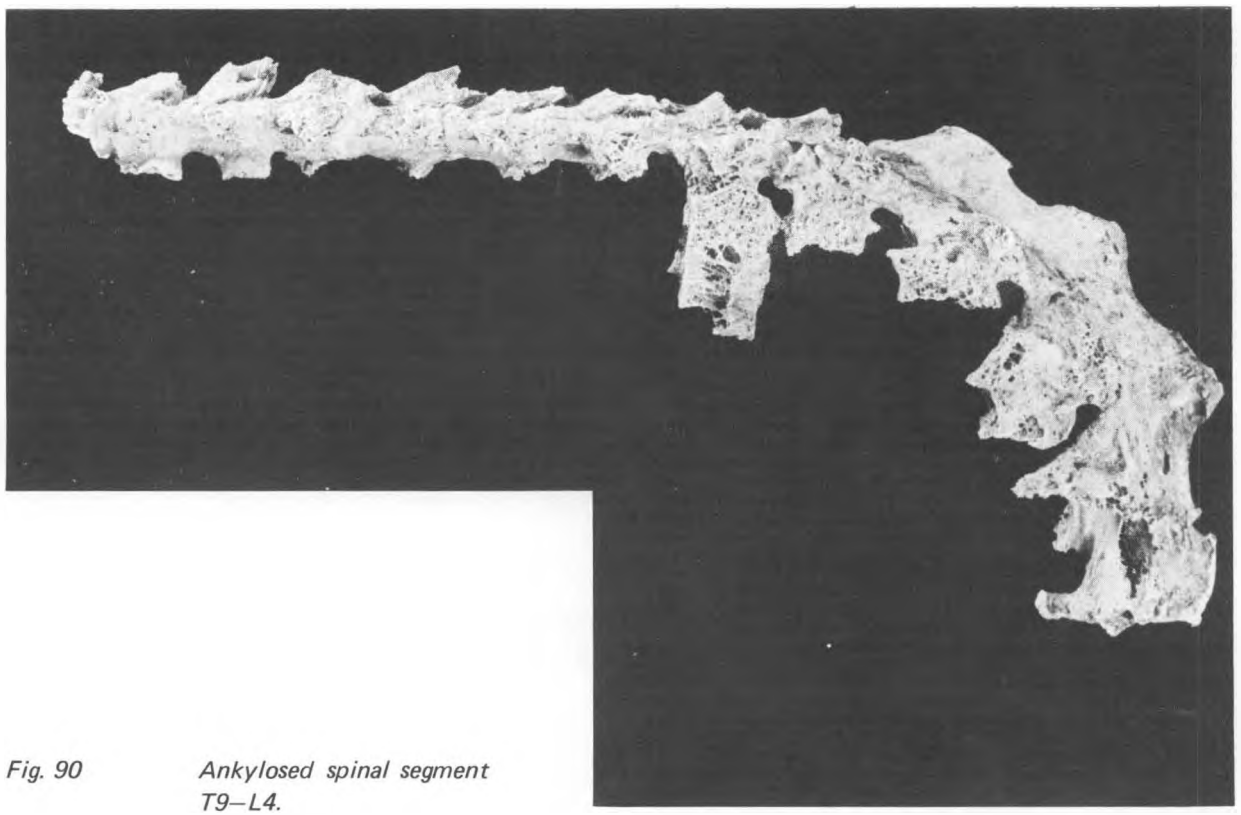


Fig. 90 *Ankylosed spinal segment T9–L4.*

Fig. 91. *Degenerated medial articular surface of the right clavicle.*

Fig. 92.
Vertebral plug showing osteoporosis.

lated network of bone as an outer surface. The cranium is also osteoporotic, though only in those areas where no connective tissue attaches.

Osteophytosis: The presence and degree of osteophyte formation (the bony lipping of the superior and inferior borders of the vertebral bodies immediately lateral to the anterior longitudinal ligament) was observed for each of the burials. Unfortunately, the present sample is too small to give accurate indications of which spinal segments in the population are more susceptible to osteophytosis. However, it *is* clear that vertebrae T10 — L5 have greater incidences of involvement than the rest of the vertebrae.

Infections

The material contains three instances of infectious agents causing modification of osseous tissue:

Burial 2: The radial tuberosity of the left radius has a suppurative scar in its centre, possibly the result of inflammation and infection of the bursa between the biceps tendon and the tuberosity.

Burial 10: A large rectangular osteitic scar with extensive new bone formation stretches from the posterior parts of the parietal bones near lambda, along the sagittal suture, through bregma, ending in two shallow elongated depressions on either side of the mid-frontal line near the frontal bosses (Fig. 93). The involved bone is very irregular in contour with an increased porosity interspersed with areas of bone sclerosis, especially along the sagittal suture. The scar measures 15.2 cms. anterior-posterior, by 5.7 cms. transversely throughout its length, and is raised 0.2 — 0.3 cms. above the surrounding normal bone. There is no corresponding involvement of the inner table.

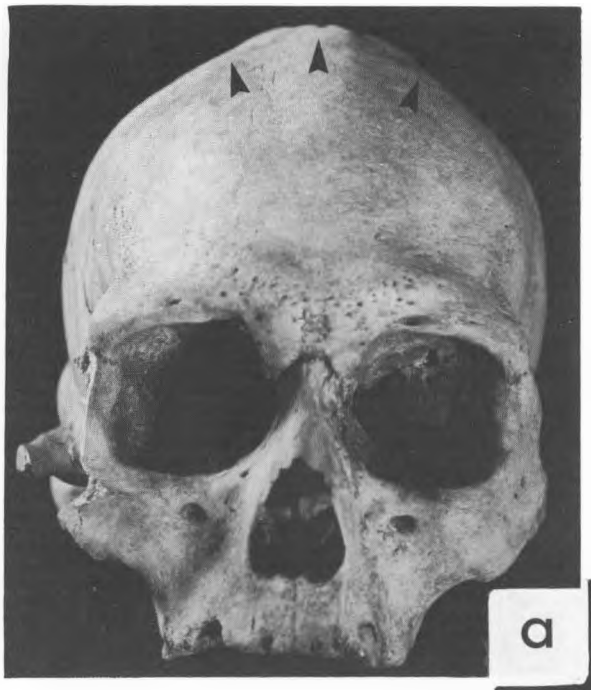
Burial 17: The bodies of lumbar vertebrae 3 and 4 have undergone massive osseous destruction:

L3—To the left of the body midline is a large aperture encroaching into the centrum. The lower vertebral border is involved by this hole and much of the central area of the inferior surface of this vertebra has been eaten away. This erosion expands backwards to finally take up the whole interpedicular surface of the body (except for the superior vertebral border).

L4—The pathologic agent of L3 is extended into L4. The central one-half of the body is completely eroded superiorly. The inferior surface is intact. Two large openings occur in the anterior surface of the body. The largest lay in the midline, the other to the left of this. The few portions remaining of the anterior superior border of the body have heavy syndesmophyte formation.

There is no involvement of the neural arch nor vertebral body collapse in either L3 or L4.

What seems to be the likely cause of the lesion is an advanced acute pyogenic staphylococcal infection of the intervertebral disc that has spread superiorly, inferiorly, and posteriorly into the adjacent vertebral bodies. The lesion is identical to that described by Kemp et al. (1973) in a clinical study of pyogenic infections of intervertebral discs. Figure 94



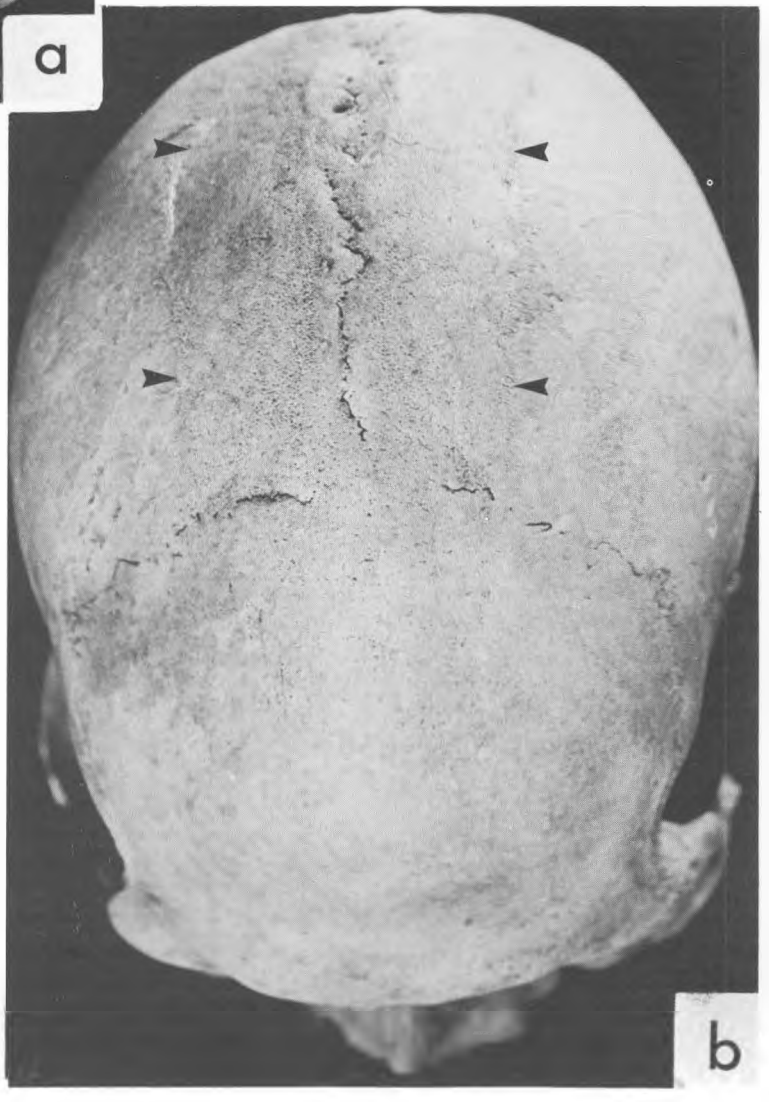


Fig. 93. *Arrows demarcate area of osteitic involvement in burial 10 from DgRr 1.*
a, Note the buildup of bone along the sagittal suture.
b, The extent of bone porosity and sclerosis can easily be seen in the involved area. The sclerosis is most evident along the sagittal suture.

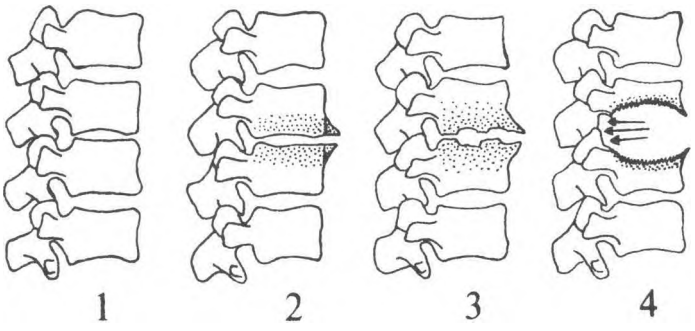


Fig. 94. *The features of pyogenic infection arising primarily in the intervertebral disc. 1. The earliest sign is narrowing of the intervertebral disc; 2. It is followed by an increase in the density of the adjacent areas of the proximal and distal vertebral bodies; 3. After a variable period, erosion of the vertebral plates occurs and is associated with reactive bone sclerosis; 4. Attempts at healing may occur by circumferential bone bridging. The remaining lesions show evidence of progression characterized by ballooning of the affected disc space and an extension of density to involve the vertebral body remnants. (adapted from Kemp et. al. 1973:701).*

shows and describes the various stages of osseous destruction. The fourth stage illustrated also represents the state of vertebrae L3 and L4 in Burial 17.

Pressure exerted backward onto the spinal cord as a result of a stage 4 infection frequently causes temporary paraplegia, and if the inflammatory process erodes the meninges and invades the spinal cord, irreversible paraplegia results (Kemp et. al. 1973: 707;709). It is conceivable that paraplegia and infection of the meninges occurred in Burial 17 from pressure on the cauda equina at the level of L3, and that this paraplegia along with the transport of the infectious agent within the meninges resulted ultimately in the death of the individual.

Tumours

There is a single instance of a possible benign bone tumour in burial 3. On the mid-lateral surface of the right tibia one-fifth of the way down the shaft is a nodule of bone, roughly circular in shape (1.2 cms. in diameter) and rising 0.3 cms. above the surrounding cortex. The central core of the nodule is more prominent and granular than the peripheral mounding of sclerotic bone. This description may indicate an osteoid osteoma, which is a highly distinctive benign bone tumour. It occurs mainly in young adults under 30 years of age, and it affects males over females by a ratio of 2:1 (Lichtenstein 1972; Robbins 1962). The tibia and femur account for at least one-half of osteoid-osteoma cases (Dahlin 1967). Radiographs of the Burial 3 tibia are to be taken, and if these reveal a central nidus surrounded by sclerotic bone formation, a diagnosis of osteoid osteoma may be justified.

Miscellaneous

The right scapula of Burial 2 has a small, hollow bony nodule (1 cm. by 1 cm.) located on the costal surface near the upper lateral border that may be a bone cyst.

Dental Disease

A majority of the maxillae from the sample are highly fragmented, and in a number of cases the mandibulae were not recovered during excavation. As a consequence of this situation only a brief description of the recognizable dental pathology follows here:

Burial 1: Six maxillary teeth have abscesses that were active at time of death, and two more healed abscesses are present with associated tooth loss. The mandible from this individual was not recovered.

Burial 2: Only three maxillary and eight mandibular teeth remain with this individual, the balance having been lost before death. Of these eleven remaining teeth, the maxillary right second molar and the

mandibular right and left first molars are carious and abscessed.

Burial 5: There are two abscesses present in the mandible: one active at the right first molar, and one healed with related tooth loss at the left first molar. The maxilla from this individual is too fragmented for dental observations.

Burial 10: All the maxillary teeth were lost before death, except the right third molar and left canine. The mandible was not recovered for Burial 10.

Burial 16: This is another burial lacking a mandible. In the maxilla there are three abscesses: at the right first premolar, the right lateral incisor, and the left first premolar.

Trauma

The incidence of trauma is quite high in the sample, occurring in 42.9% of the observed burials. The most common site of involvement is the vertebral bodies, though evidence of local trauma in the appendicular skeleton is also present.

Burial 1: On the superior surfaces of the vertebral bodies of T12, L1, and L2 are open lesions into the centre of the bodies. These lesions, averaging 1.1 cms. anterior-posterior by 2 cms. transversely, are probably the result of prolapse or herniation of the nucleus pulposus through the cartilaginous end plate of the intervertebral disc into the vertebral bodies. These herniations are referred to as Schmorl's nodes and they may occur as the result of injury or spontaneously (Bourke 1967). In this case, because the bodies of T12 and L1 have definite anterior compressions, a local trauma resulting in compression fractures is indicated.

Burial 2: The first lumbar vertebra is compressed anteriorly and is possibly a healed compression fracture. T11 is also compressed, though to a lesser degree than L1.

Burial 5: The superior left articular facet of the axis vertebra has been fractured, slightly separated, and healed, leaving an hourglass-shaped pitted depression in the middle of the facet. The anterior – posterior dimension of the facet has been correspondingly increased by 0.3 cms. The opposing facet of the atlas, although apparently not fractured, is similarly enlarged.

On the mid-right half of the frontal bone is a healed circular shallow lesion (1.2 cms. by 1.2 cms.) that exposes the diploë. It is possible that the lesion is the result of a heavy blow to the head, resulting in a small area of bone necrosis and regeneration. The inner table is not affected.

Burial 8: The posterior-medial one-third of the lateral condyle of the right tibia has been fractured, depressed 0.1 cms., and healed. The fracture site is marked by a ridge of porous bone.

Burial 13: A thoracic vertebral body (number ?) is compressed anteriorly and laterally to the left, and may represent a healed compression fracture. The pronounced lateral wedge-shape of the vertebra would probably have caused a moderate scoliosis.

Burial 15: The right lateral inferior border of the body of a mid-cervical vertebra shows rarefaction and upward compression, and may be the result of a compression fracture with intervertebral disc degeneration.

The anterior, medial one-half of the left tibial medial condyle is present. The posterior one-half of this fragment has a fracture line and associated nodular bone formation.

Trephination

A possible case of skull surgery is represented in Burial 8. In the right posterior quadrant of the frontal bone, near the midline, is a large oval healed perforation measuring 2.6 cms. anterior-posterior and 1.5 cms. transversely (Fig. 95). Slight bone regeneration is evident around the margin of this opening, which is surrounded by a ring of rarefied osteitic bone. This is in turn surrounded by a slightly mounded ring of sclerotic bone, making the total involved area 6.1 cms. anterior-posterior by 5.1 cms. transversely. The bevelling of the wound indicates that it was probably scraped open. The fact that the individual lived on for a relatively long period after the 'operation' is demonstrated by the osteitic changes and the amount of bone regeneration, a very slow process in cases of trephination (Lisowski 1967).

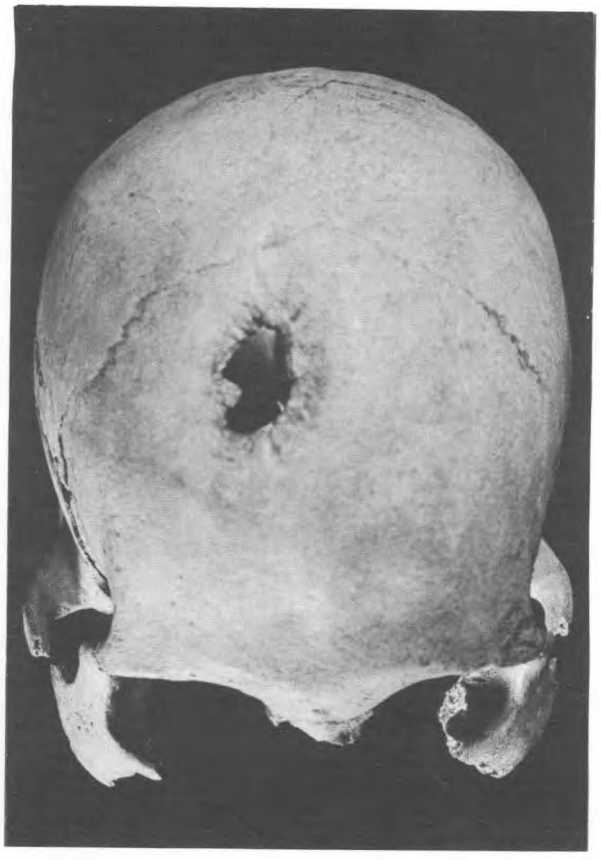


Fig. 95. Possibly an example of trephination.

Table 2. Pathologies

Burial Number	Degenerative Arthritis	Infections	Tumours	Bone Cysts	Dental Disease	Trauma	Trephination
1	X	X			X	X	
2	X			X	X	X	
3	X		X			X	
4	X						
5	X				X		
6	X						
7							
8	X					X	X
10	X	X			X		
13	X					X	
15						X	
16	X				X		
17		X					
18							

Discussion

Table 2 shows the distributions in the total observable sample of the pathologies previously described. Out of these fourteen individuals, 12 (85.7%) have at least one pathological condition. Ten (71.4%) individuals have pathologies other than degenerative arthritis. The relatively advanced ages of most of the burials generally account for the presence and degree of osteoarthritis, osteophytosis, and dental disease. There are no indications of any deficiency diseases in the sample.

Significant is the high incidence of trauma (42.9%) to the vertebral bodies and tibial condyles in both sexes. These types of fractures suggest a rigorous lifestyle consisting of activities resulting in substantial vertical compression on the major body-supporting skeletal structures.

It is also significant that the trephined skull belongs to the individual suffering from ankylosing spondylitis (Burial 8). The coincidental occurrence of two relatively rare conditions seems hard to believe. The skull surgery may have been a drastic form of treatment for what must have been a very painful malady.

The skeletal pathology of these prehistoric peoples gives us a hint of what some aspects of life must have been like on the Northwest Coast around 3000 years ago: Diet was sufficient to prevent detectable deficiency diseases; everyday activities were very strenuous, taking their toll on the skeleton through the years in the form of vertebral collapse and degenerative arthritic changes; there is evidence that trephination was practised during this period and a number of relatively uncommon pathologies occur in the sample, but the lack of further data prevents any comparisons to frequencies of the diseases in modern populations.

The diagnosis of pathological conditions solely from the bones of the skeleton is full of pitfalls — many different diseases can express themselves in nearly identical osseous lesions and alterations. Therefore, it is never wise to state absolutely the cause of a pathological state unless the information is very convincing (e.g. Burial 8). The diagnoses described in this paper are subject to revision after radiological and biochemical analyses have been carried out.