

Evidence of Periostitis in Joseon Dynasty Skeletons

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Abstract : Periostitis is one of the human diseases commonly encountered in archaeological samples. It is known to be an important health indicator for paleopathologists examining skeletal remains. In our recent study on a Joseon skeletal series (n=101), non-specific, primary periostitis was observed only in five individuals (#4, #29, #137, #175, and #290). Notably, there were no secondary periostitis-suggestive signs (e.g. syphilis), except for those caused by fractures (#33 and #41). As this is the inaugural Korean-skeletal-series report on periostitis, the results presented in these pages should prove significant to interested paleopathologists.

Keywords : Joseon, Periostitis, Skeleton, Syphilis, Paleopathology

Introduction

Osteological evidence of diseases in archaeologically obtained human skeletal samples is very important to bio-anthropologists and paleopathologists, as it is very helpful for, even essential to, any comprehensive understanding of health and disease patterns in historical populations. This notwithstanding, it is only quite recently that archaeological skeletons in Korea have been investigated for such purposes, given that there have heretofore been very few skeletal series available from Korean museums, universities or institutes. Joseon Dynasty (1392 ~ 1910 AD) tombs typically provide relatively good-preservation-status of cultural and human remains, and have yielded many constructive

osteological traces of human diseases. The relevant papers have reported on diffuse idiopathic skeletal hyperostosis [1], dental caries [2], enamel hypoplasia [3], vertebral degenerative changes [4,5], degenerative joint disease [6,7], and trauma [8]. Although these osteoarchaeological results are impressive, many aspects of paleopathology, for the reason above-mentioned, remain elusive in Korea.

Periostitis, though it is becoming increasingly rare in the present day, is one of the most commonly encountered abnormalities in archaeological samples, prior to the discovery of antibiotics and their use as a medical treatment modality [9]. Periostitis is classified as either *primary* or *secondary*. *Secondary* periostitis is caused by specific infectious disorders such as syphilis. Of course, we cannot deny that the term *primary* periostitis, as applied to archaeological skeletal samples, has perhaps been used only in cases of unknown etiology [9]. The presence of periostitis has been reported worldwide as an important health marker of archaeological skeletons [10-14].

However, as in the case of some other pre-modern diseases, there have not yet been any reports on evidence of periostitis in Korean skeletal series. In the present study, in

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Table 1. Periostitis in the examined cases

| Box no. | Sex | Age | Periostitis | Pathological descriptions |
|---------|-----|--------------|-------------|---|
| 1 | M | Old (AS) | × | None |
| 2 | M | Old (AS) | × | None |
| 4 | M | Old (AS) | ○ | Osteoperiostitis in frontal bone |
| 6 | M | Old (AS) | × | None |
| 9 | M | Middle (AS) | × | None |
| 10 | F | Young (AS) | × | None |
| 12 | F | Middle | × | None |
| 14 | F | Young (AS) | × | None |
| 15 | ? | Old (suture) | × | Sex could not be determined by osteological criteria Highly developed entheses of pectoralis major attachment site in humerus (not pathologic) |
| 16 | F | Old (AS) | × | None |
| 18 | F | Old (AS) | × | None |
| 19 | F | Young (AS) | × | None |
| 21 | F | Adolescent | × | None |
| 24 | M | Middle (AS) | × | None |
| 26 | F | Middle | × | None |
| 27 | F | Old (AS) | × | None |
| 28 | F | Middle (AS) | × | None |
| 29 | M | Old (AS) | ○ | Periostitis in both side humerus |
| 30 | F | Young (AS) | × | None |
| 31 | F | Old (AS) | × | None |
| 32 | M | Young | × | None |
| 33 | F | Middle (AS) | ○ | Periostitis in Lt femur: Osteomyelitis; Fracture (secondary to fracture) |
| 34 | M | Old (AS) | × | None |
| 35 | F | Young (AS) | × | None |
| 36 | M | Old (AS) | × | None |
| 37 | F | Old (AS) | × | None |
| 38 | M | Old (AS) | × | None |
| 39 | F | Middle (AS) | × | None |
| 41 | M | Old (AS) | ○ | Periostitis in Colle's fx healing site (Rt radius) (secondary to fracture) |
| 43 | M | Old (AS) | × | None |
| 44 | F | Old (AS) | × | None |
| 45 | M | Old (AS) | × | None |
| 46 | F | Middle (AS) | × | None |
| 47 | M | Old (AS) | × | None |
| 48 | M | Middle (AS) | × | None |
| 49 | F | Middle (AS) | × | None |
| 50 | M | Middle (AS) | × | None |
| 54 | M | Young (AS) | × | None |
| 55 | M | Old (AS) | × | Ossification of costal cartilage Ankylosis of sternoclavicular joint (associated with DISH) No periostitis |
| 57 | F | Old (AS) | × | Rheumatoid arthritis |
| 64 | F | Old (AS) | × | None |
| 65 | M | Old (AS) | × | None |
| 69 | M | Middle (AS) | × | None |
| 70 | F | Young (AS) | × | None |
| 71 | F | Middle (AS) | × | None |
| 74 | M | Young (AS) | × | None |
| 75 | F | Old (AS) | × | Enthesitis (enthesopathy) of left radial tuberosity Pathologic but not diagnosed as periostitis |
| 78 | F | Middle (AS) | × | None |
| 80 | F | Young (AS) | × | None |
| 81 | M | Middle (AS) | × | None |
| 82 | M | Old (AS) | × | None |

Table 1. Continued

| Box no. | Sex | Age | Periostitis | Pathological descriptions |
|---------|-----|-------------|-------------|--|
| 83 | M | Adolescent | × | None |
| 84 | M | Middle (AS) | × | None |
| 85 | M | Old (AS) | × | None |
| 87 | F | Young (AS) | × | None |
| 88 | M | Middle (AS) | × | None |
| 89 | F | Middle (AS) | × | None |
| 94 | M | Middle (AS) | × | None |
| 98 | M | Middle (AS) | × | None |
| 99 | F | Middle (AS) | × | None |
| 100 | M | Middle (AS) | × | None |
| 101 | F | Middle (AS) | × | None |
| 102 | M | Middle (AS) | × | None |
| 103 | F | Middle (AS) | × | None |
| 107 | M | Middle (AS) | × | None |
| 110 | M | Middle (AS) | × | None |
| 112 | M | Old (AS) | × | None |
| 113 | F | Middle (AS) | × | None |
| 114 | F | Middle (AS) | × | None |
| 115 | M | Middle (AS) | × | None |
| 116 | M | Old (AS) | × | None |
| 120 | F | Middle (AS) | × | None |
| 123 | M | Middle (AS) | × | None |
| 129 | M | Middle (AS) | × | None |
| 134 | F | Middle (AS) | × | None |
| 137 | M | Old (AS) | ○ | Periostitis in left femur |
| 140 | M | Middle (AS) | × | Lytic enthesopathy of costoclavicular ligament attachment site Pathologic but not diagnosed as periostitis |
| 145 | M | Middle (AS) | × | Lytic enthesopathy of costoclavicular ligament attachment site Pathologic but not diagnosed as periostitis |
| 159 | M | Old (AS) | × | None |
| 160 | F | Middle (AS) | × | None |
| 162 | M | Middle (AS) | × | None |
| 169 | M | Middle (AS) | × | None |
| 171 | M | Middle (AS) | × | None |
| 172B | M | Old (AS) | × | None |
| 173 | F | Middle (AS) | × | None |
| 175 | F | Middle (AS) | ○ | Periostitis in right tibia |
| 177 | M | Middle (AS) | × | None |
| 198 | F | Young (AS) | × | None |
| 200 | F | Old (AS) | × | None |
| 201 | M | Middle | × | None |
| 219 | M | Middle (AS) | × | None |
| 220 | M | Old (AS) | × | None |
| 221 | F | Middle (AS) | × | None |
| 225 | M | Middle (AS) | × | None |
| 226 | M | Old (AS) | × | None |
| 227 | F | Middle (AS) | × | None |
| 228 | F | Old (AS) | × | None |
| 229 | M | Middle | × | None |
| 230 | M | Middle (AS) | × | None |
| 234 | M | Middle (AS) | × | None |
| 236 | M | Old (AS) | × | None |
| 237 | M | Middle (AS) | × | None |
| 249 | F | Middle | × | None |
| 290 | M | Old (AS) | ○ | Periostitis of bilateral iliopubic eminence of hip bones Highly developed entheses of pectoralis major attachment site (not pathologic) |

order to shed light on the periostitis pattern in a pre-modern Korean population, we examined periostitis-suggestive osteological traces in a Joseon Dynasty skeletal series.

Materials and Methods

Skeletons (n=101) maintained in the Joseon Dynasty Human Sample Collection were examined in this study. Every such sample initially was confirmed to date from the 16th to 18th centuries, as based on the contextual archaeological evidence and carbon dating results [1,4,15]. Sex was determined in each case by reference to the shape of the mastoid process or sciatic notch [16]. Age at death was estimated by the method of Lovejoy et al. [17]. The individuals were classified as adolescent (12~20 years), young adult (20~35 years), middle-aged (35~50 years), and old-aged (over 50 years) groups according to the following osteological indicators: the degrees of transverse organization, granularity, apical activity, retro-auricular activity, and articular surface porosity.

We thoroughly examined the collection for the periostitis when two or more parts of bone elements exhibited active or healed lesions with microprosity and bony spurs as including in the specimen by the presence of at least 50% of individual skeleton. Such signs included many layers of bone parallel to the surface of the underlying bone, Codman's triangle, a thick bony layer with an irregular surface, bony spicules perpendicular to the underlying cortex, and the presence of woven bone on a porous-seeming bony surface, among others [9]. Bones very close to the skin (e.g. the calvaria or anterior surface of the tibia) were searched especially carefully for evidence of the disease [9]. As for the kinds of traumatic injuries identified in our previous study [4], we also, in the present case, determined whether they were accompanied by any signs of periostitis.

We also looked for osteological-evidentiary traces of periostitis that might have been caused by specific infections [9], for instance syphilis (*tertiary syphilis*). The presence of *caries sicca*, a sign of tertiary syphilis in calvaria, was confirmed by central lytic bone destruction with peripheral porotic change of periosteal-reactive bone. We were aware that tertiary-syphilitic bone changes are frequently observed in the tibia, the bones surrounding the nasal cavity, and the cranial vault [9,18].

Results

Our results are summarized in Table 1. Primary periostitis was observed in five individuals (#4, #29, #137, #175, and #290). It was found in the frontal bone of the skull (#4), in the humerus (#29), the femur (#137), tibia (#175), and in the hip bones (#290) as well. Generally, as the calvaria and anterior surface of tibia are situated just beneath the skin, they can be damaged by recurrent minor trauma, finally becoming the most commonly involved periosteal sites [9,18]. Significantly, in this study, we also observed signs of primary periostitis in the calvaria and tibia (cases #4 and #175).

Specifically, in case #4, we found periostitis to the middle and left on the frontal bone, about 10.8 mm from the bregma. The overall area was 64.25×37.5 mm. The porous skull surface showed little sign of taphonomic changes (Fig. 1A and 1B). In case #29, the signs, increased microporosity and small body spur, were in the bilateral surgical neck of the humerus, where new bone formation and periosteal-reactive bone changes were observed (Fig. 1C and 1D). Although highly developed entheses at the subscapularis were discovered, it appeared to be degenerative change rather than a pathological sign. A porous-seeming left-femur surface, which might have been the healing site of a traumatic injury (e.g. green-stick fracture) in youth (Fig. 2A to 2C), was found in case #137. In case #175, we found periosteal signs on the posterior surface of the right tibia (Fig. 3A and 3B). Similar signs were observed in case #290 as well, where periostitis in the bilateral iliopectic eminence of the hip bones was discovered (Fig. 3C).

Bony changes in two previously reported fracture cases (#33 and #41) [19] are likely to be caused by secondary periostitis. In case #33, there were periosteal signs at a femur-fracture site. Periostitis induced by Colles' fracture could be seen also in case #41, wherein, on the bone surface, signs of porosity were apparent. Except for these, we could not find any other bony changes suggestive of secondary periostitis in the collection. The osteological signs of tertiary syphilis could not be discovered by us at all.

Discussion

In a previous study on pre-and post-Columbian Pecos Pueblo skeletal remains, periostitis was diagnosed in 13 of

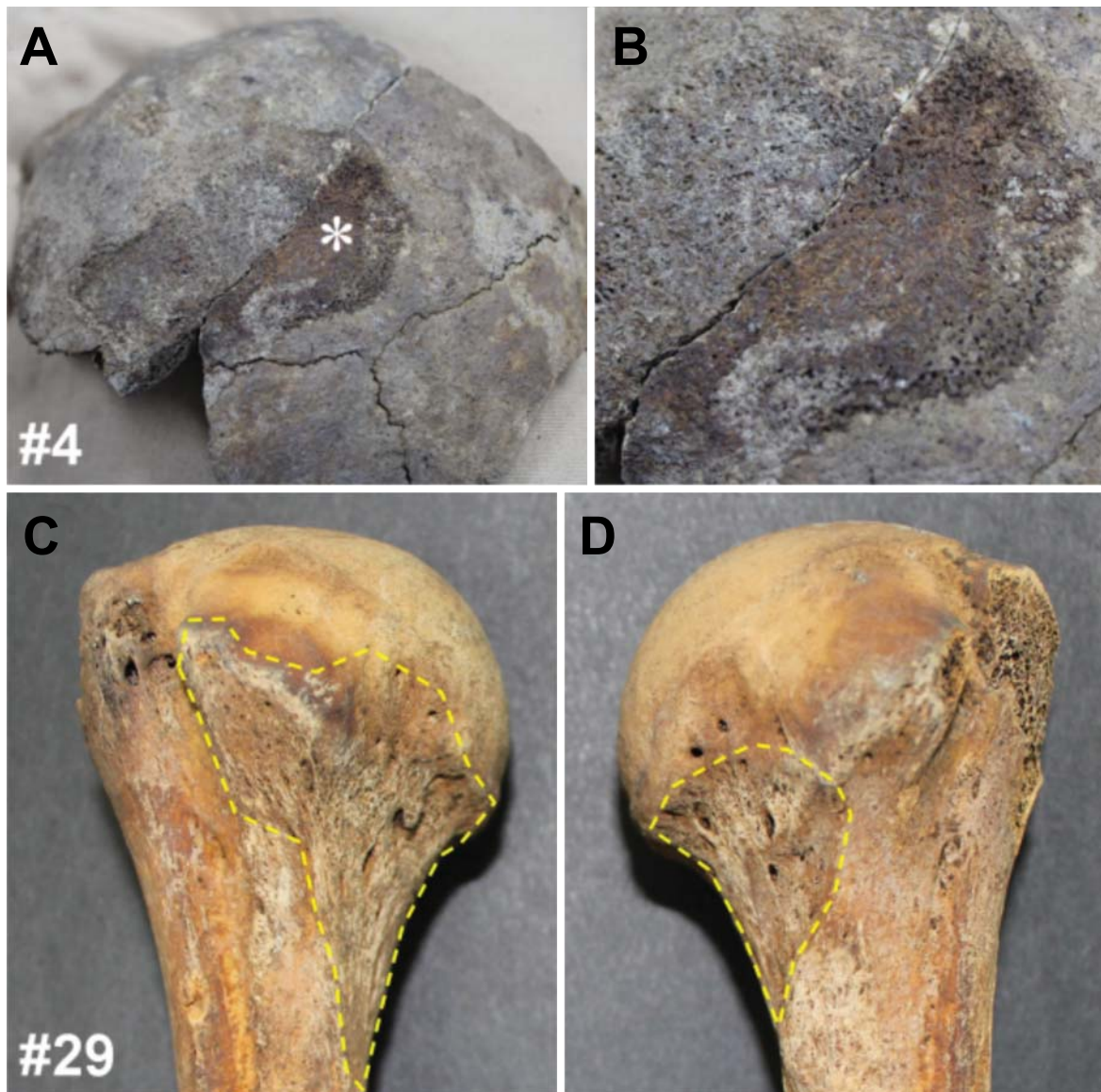


Fig. 1. (A) and (B) Periostitis (asterisk) in frontal bone in case #4. (B) is a magnified image of (A). The surface of the skull was porous. (C) and (D) Periostitis in case #29. (C) Right humerus. (D) Left humerus. In the surgical neck of the humerus, periosteal changes could be observed (areas marked by broken lines).

503 (2.6%) skeletons [20]. By sharp contrast, the skeletal samples of the Roman period (3rd~5th centuries) found in Croatia showed periosteal frequencies as high as 66.7% for subadults and 30.4% for adults. In the medieval Polish skeletal samples (10~13th century AD), the prevalence of periostitis was shown 16.7% (8/48) for subadult and 42.2% (35/83) for adult. In the 12~15th century skeletal sample of the southern Croatian, 20% (4/20) for subadult exhibit the periostitis and 12.1% (7/58) was for adult [21,22].

The authors speculated that these higher incidences re-

flect the relatively low quality of life of those historical people, which condition in that particular walled city, they further surmised, was the result of overcrowding, poor sanitary conditions, and consequent, rampant infectious diseases [14]. In general, periostitis in archaeological skeletons is known to be an important indicator of response to various stresses. Its prevalence increased as economic and/or societal conditions worsened [9].

In the present study, we did find five cases of primary periostitis (4.9%). This prevalence, just slightly higher than

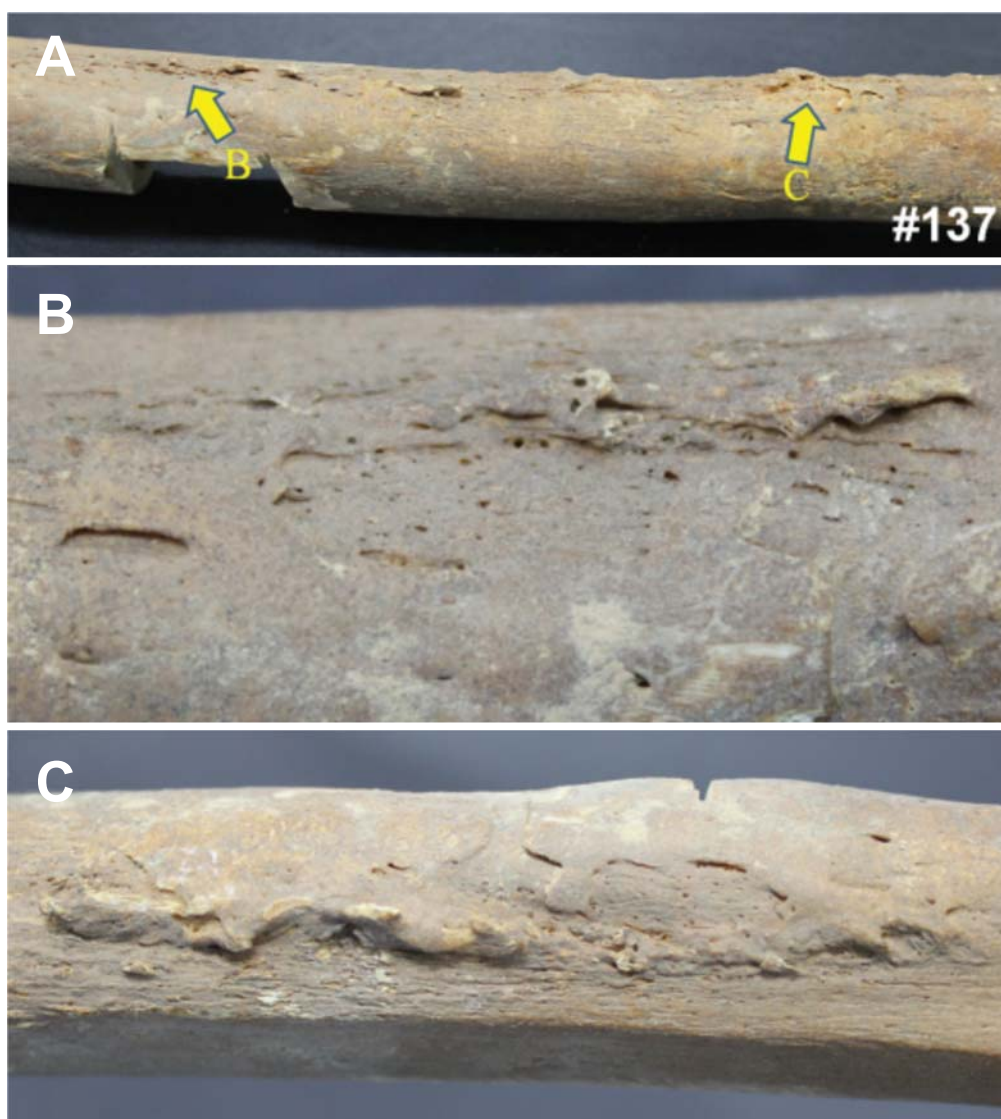


Fig. 2. (A) Porous-seeming surface in left femur, possibly caused by periostitis, in case #137. (B) and (C) are magnified images in (A).

that of the above-mentioned pre- and post-Columbian Pecos Pueblo people, is, perhaps surprisingly, far lower than that of the just-noted Roman-period Croatians. How can this be explained? Actually, it was well known to us that the samples we examined in the current study are the remains of individuals buried in *Hoegwakmyo* tombs, which is to say, the remains of Joseon Dynasty elites [23]. The relatively tranquil lives they enjoyed might, in fact, be all the explanation that is needed. A final, definitive answer, however, must await the examination of additional samples.

In this study, we also paid particular attention to secondary periostitis. In the trauma cases previously reported [19], we found osteological signs of secondary periostitis. How-

ever in case of periostitis caused by specific infections (e.g. syphilis), we could not find any osteological evidences in our collection. Syphilis was the major venereal pathogen prevalent among urban adult populations prior to the discovery and application of antibiotics. Many countries in those earlier years and centuries suffered estimated infection rates as high as 5% [18,23]. With respect to the origin of syphilis, a number of theories have been debated among paleopathologists around the world. Some researchers have posited “the Columbian Origin of Treponematoses”, according to which syphilis was originally indigenous to America, and then spread to other parts of the world, especially the Old World, after Columbus’ discovery [18,24-27].

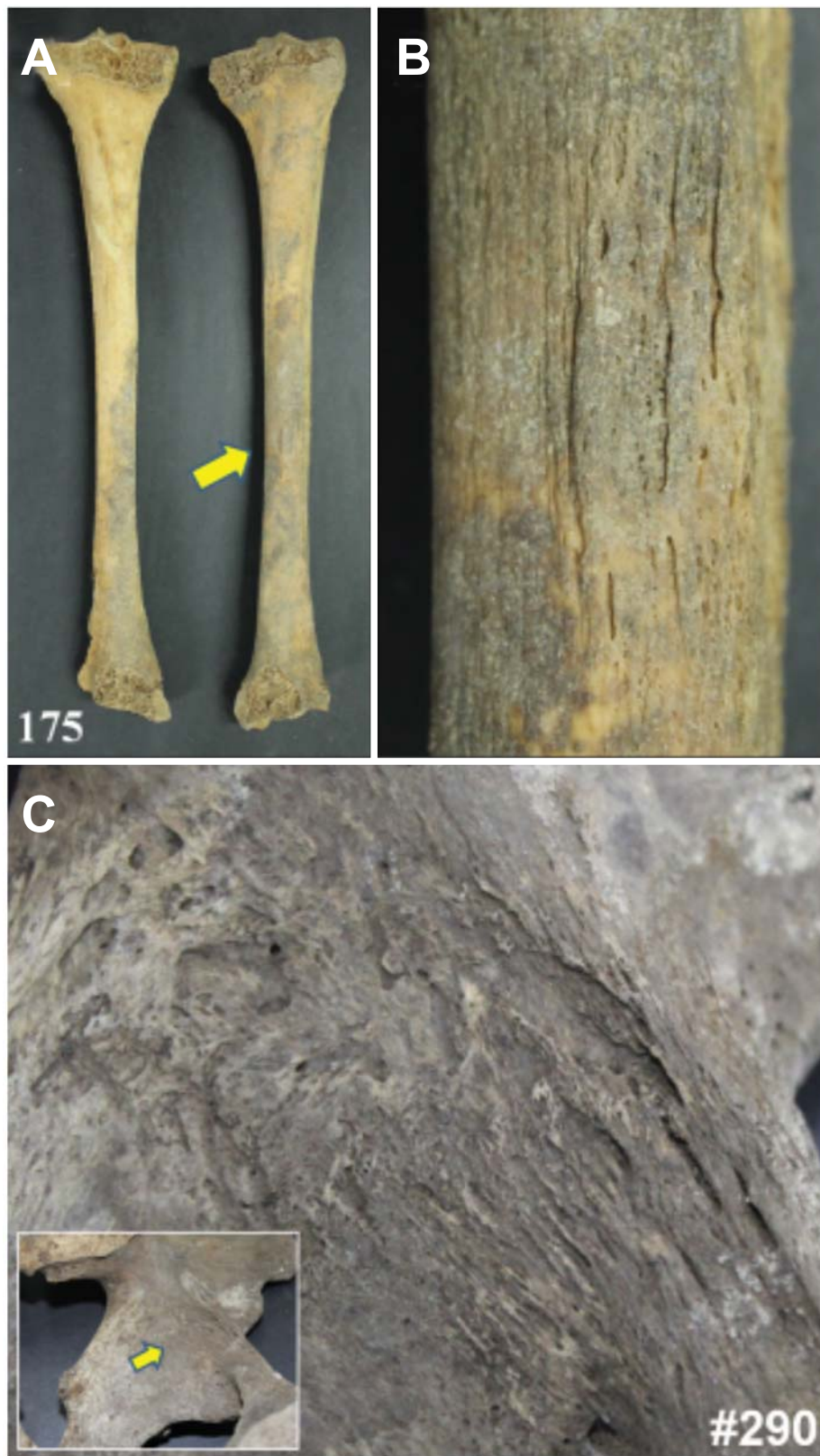


Fig. 3. (A) and (B) Case #175. (A) Periostitis in right tibia (indicated by arrow). (B) is a magnified image of the periostitis in (A). (C) Periosteal trace observed in hip bone in case #290 (indicated by arrow in inset).

Since osteological investigations have turned up only very rare instances of syphilis in pre-1492 Old World samples, the Columbian origin of treponematoses does seem reasonable [9,28]. However, more studies on Old World samples are still needed for confirmation of hypothesis because another research group still insisted that syphilis was established in the Old World even before the discovery of the Americas [18,29]. Certainly, if Old World skeletal series of 1492 or earlier were to show osteological evidence of syphilitic infection, the argument would take on a whole new complexion [30].

However, no reports of any osteological signs of tertiary syphilis in archaeologically obtained skeletal series have yet been published in Korea. The present Joseon skeletal-series study, likewise, discovered no such evidence. According to medical historians, syphilis seems to have been introduced to Korea from China, possibly between 1506 and 1521 [31,32]. Many more skeletal samples will need to be examined in forthcoming studies, for more decisive conclusion on the history of syphilis in Korea.

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조선시대 유골에서 확인된 뼈막염

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간추림 : 뼈막염은 고고학 유골에서 가장 흔히 발견되는 질병 중의 하나이며, 유골의 생전 건강상태를 가늠할 수 있게 해주는 중요한 생물학적 지표이다. 조선시대 뼈모음을 조사한 결과, 총 101명의 뼈대 중 5명의 뼈대 (#4, #29, #137, #175, #290)에서 기저질환이나 손상을 보지 못하는 일차뼈막염이 발견되었다. 한편, 매독에 속발된 뼈막염을 관찰할 수 없었는데 향후 뼈모음의 수가 늘어난다면 이 부분에 대한 중요한 고병리학적 발견을 기대할 수 있을 것으로 생각하였다. 이상으로 조선시대 고인골에서 발견된 뼈막염을 처음으로 보고하게 되었으며, 앞으로 다양한 고병리학적 소견에 대한 형태학적 연구를 진행할 예정이다.

찾아보기 낱말 : 뼈막염, 조선, 뼈대, 매독, 고병리학