University of Montana Forensic Case #12: Comprehensive Case Analysis

Lauren Leanne Richardson

The University of Montana

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Acknowledgments

I would like to start out by dedicating this book to my parents Jim and Daphne Richardson, as well as my siblings Nicholas and Kyla. Without their love, support and limitless encouragement I would never have successfully completed seven years of college. In addition, I would also like to expand my gratitude to my extended family and friends who have also given immense encouragement throughout the years. However this comprehensive case analysis would not have ever been possible without the guidance and extensive knowledge provided by my chair and advisor Dr. Ashley McKeown. Words cannot express my appreciation for her support and educational expertise. I would also like to thank my other committee members, Dr. Randall Skelton and Dr. James Burfeind, who also supplied significant amounts of support and knowledge that contributed substantially to my successful completion of the masters program. Another individual who selflessly aided me in this process is Dr. Walter Kemp. I am extremely grateful for his generosity to share his expertise with me, without which, I could never have answered difficult questions and discovered other pathologies affecting this case. Thank you to everyone for your support and encouragement.
Abstract

The remains labeled University of Montana Forensic Case #12 (UMFC 12) were unearthed on August 30, 1983 during the construction of Cruse Avenue in Helena, Montana near the old School Administration Building on Allen Street. Construction workers, using a bulldozer accidently exposed the decomposing grave (Roesgen, 1983). It has been speculated that these remains might belong to a Chinese laborer dating back to the gold rush (Joyce, 1983). An 1884 map of Last Chance Gulch, in which the remains were discovered, indicate that a Chinese cemetery is in the area but the exact coordinates have never been determined (Joyce, 1983).

After an in-depth analysis of the remains present it has been determined that the remains are most consistent with an adult white male individual between the ages of 24 to 40 years old, with an approximate height of 62.8-67.8 inches. There appears to be some pathological abnormality affecting the cranium and the right humerus. No obvious antemortem or perimortem trauma is visible on the remains, but there is extensive postmortem breakage. The noticeable staining and deterioration present on the skeletalized remains would indicate that these remains are not recent. It is possible that they could be historic. Additional data, such as associated artifacts or association with datable natural or cultural features, would be needed to suggest a narrower time since death range.
Table of Contents

Acknowledgements ………………………………………………………………………………..ii

Abstract …………………………………………………………………………………………….iii

Table of Contents …………………………………………………………………………………..iv

Figure Index ………………………………………………………………………………………..v

Table Index …………………………………………………………………………………………vi

Introduction ………………………………………………………………………………………….1

Background …………………………………………………………………………………………2

Inventory …………………………………………………………………………………………….4

Methods …………………………………………………………………………………………….7

Biological Profile ……………………………………………………………………………………..12

   Sex Estimation …………………………………………………………………………………….12

   Age Estimation ……………………………………………………………………………………16

   Dentition ……………………………………………………………………………………….18

   Ancestry ……………………………………………………………………………………….20

   Stature …………………………………………………………………………………………22

Taphonomic Alterations ……………………………………………………………………………23

Preservation Assessments …………………………………………………………………………..24

Pathological Conditions …………………………………………………………………………..26

Associated Cultural Artifacts …………………………………………………………………….30

Literature Review: Cribra Orbitalia and Porotic Hyperostosis ………………………………..31

Conclusion ………………………………………………………………………………………….37

Bibliography ………………………………………………………………………………………..38
Figure Index

- Figure 1A- Skeletal Remains in Anatomical Position (Full View) .........................6
- Figure 2- Os coxae ..................................................................................................13
- Figure 3-Upper Skeleton (Superior View) .................................................................17
- Figure 4A- Mandibular Dentition ...........................................................................19
- Figure 4B- Maxillary Dentition ................................................................................19
- Figure 5-Cranium (Frontal View) ............................................................................20
- Figure 6-Disarticulated Right View of Cranium .......................................................23
- Figure 7A-Cranium (Left View) ..............................................................................25
- Figure 7B-Should Region (Right) ............................................................................25
- Figure 8A-Humeri ....................................................................................................26
- Figure 8B-Humeri X-Ray .......................................................................................26
- Figure 9-Distal Humeri X-ray ................................................................................27
- Figure 10A-Sternal Foramen ...................................................................................28
- Figure 10B-Endo-cranial Pitting ............................................................................28
- Figure 11A-Orbital Roofs (Superior View) ...............................................................29
- Figure 11B-Left Orbital Roof ...............................................................................29
- Figure 12A-Nails in Wood .......................................................................................30
- Figure 12B-Single Nail ...........................................................................................30
- Figure 12C-Glass Fragments ...................................................................................30
# Table Index

- Table 1 - FORDISC 3.0 Sex Classification…………………………………………..14
- Table 2 - FORDISC 3.0 Ancestry Classification………………………………………...21
- Table 3 - Stature Estimation Chart…. …………………………………………………....22
Introduction

On August 30, 1983 a construction worker was bulldozing an exit ramp for the removal of the old School Administration Building on Allen Street in Helena when human remains and fragments of a coffin were exposed (Roesgen, 1983). County Coroner Mickey Nelson was contacted and arrived at the site to collect the human remains and the few remnants of the coffin. On September 1, 1983, per Coroner Nelson’s request, University of Montana anthropologist, Dr. Charline G. Smith examined the partial skeleton in his Helena office (Smith, 1983). She then visited the site where the remains were discovered and she describes it as a small cliff at the edge of a school yard that was being removed for highway construction. It was approximately eight to nine feet below the surface with signs of layering on top of the original grave site. As she began to excavate the site she discovered the remainder of the collapsed burial with nails and wooden fragments from the coffin, and removed the remaining human remains. These remains when excavated were wet and very fragile. They had roots, caliche (a hardened deposit of calcium carbonate), cloth, and wood adhering to the bones (Smith, 1983).

Dr. Charline G. Smith transported the remains to the Physical Anthropology Laboratory located in the Social Science building at the University of Montana. After analysis, Dr. Smith concluded that the remains are that of a Caucasian male around fifty years in age, approximately 5’6” in height, who most likely died around the turn of the century (Smith, 1983).
**Background**

In the summer of 1863 word was spreading from Montana across the nation that Alder Gulch was yielding bricks of gold that could be effortlessly plucked by anyone (Palmer, 1987). The rumor was that it was even easier and more plentiful picking than California. These claims drew not only individuals seeking an easy fortune but also those desperate to escape the raging Civil War’s death and destruction.

Many traveled the majority of the distance by water. Overflowing steamboats launched from St. Louis, Missouri and trekked up the Missouri River to land in Fort Benton, Montana and the passengers would then continue their journey by land to Virginia City. Among the gold mining influx were John Cowan, John Crabb, DJ Miller, and Reginald Stanley. These individuals came to be known as the “Four Georgians,” and Helena’s first settlers. However, only John Cowan actually originated from the state of Georgia (Palmer, 1987).

The flood of people caused Virginia City to be filled over capacity, leading to the circulation of rumors that gold was being found in a remote gulch approximately four hundred miles north. The goal of these tales was to clear out as many miners as possible, and it was a successful scheme. Among those leaving Virginia City for the northern wilderness were the “Four Georgians.” Well into their northbound journey they realized they were following a false claim of gold finding. Instead of continuing their expedition north they decided to follow the Blackfoot River drainage to Nevada Creek and continued over the Continental Divide to the Prickly Pear Valley between Mount Ascension and Mount Helena (Palmer, 1987). In their desperation to find the elusive gold that had drawn them to the harsh Montana wilderness they began to call the gulch their “last chance.” After they had set up camp the men set out to pan for
gold in the fading light of a long summer day in July of 1864 and Reginald Stanley found nuggets of gold (Palmer, 1987).

In the first year of discovery, Last Chance is thought to have yielded $170,000 in gold and between $10 to $35 million in total before the gold rush died out (Palmer, 1987). Throughout the late 1880s building boom in Helena, newspapers commonly ran short articles on gold accidentally discovered during construction. These stories of unintentional gold discoveries continued throughout the years, with one of the most recent articles being in 1985 after a flood washed soil from the gulches (Palmer, 1987).

While the naming of Last Chance Gulch is clearly explainable and accepted, there has been more controversy involved with how the town of Helena received its name. There are several versions of how the town was named. One account claims that the town was named after a miner’s Minnesota love interest named Helena (Palmer, 1987). An alternative report asserts that the settlement was initially called “St. Helena,” after the island which confined the exiled Napoleon. In 1962 a California man wrote to the Montana Historical Society with yet another claim stating that the city was named after his grandmother (Palmer, 1987). Another explanation, which is thought by many to be more probable, is that a group of citizens met on October 30, 1864 when John Summerville suggested calling the settlement “HeLEENa” in honor of the Heleena in Scott County, Minnesota and over time people begin to accent the word and changed the pronunciation to Helena (Palmer, 1987).
**Inventory**

One of the first steps in a case analysis is to inventory the bones present. The more complete the skeleton, the more accurate information that it can yield towards identification. That is why it is extremely important to have a trained individual on site for the recovery process. There are approximately two hundred and six bones in an adult skeleton and over eight hundred ossification centers in an infant. This number may vary slightly due to normal human variation, such as the addition of sesmoid bones.

While having as complete of a skeleton as possible is valuable for assessment some bones are more crucial in providing information in regards to sex, age, and ancestry. It is common knowledge among forensic anthropologist that the os coxae are the most reliable for estimating sex and age, while the cranium is more dependable for ancestry. However, the more bones present for examination, the more methods that can be applied leading to a greater accuracy in the evaluation.

The incomplete human remains labeled UMFC 12 are completely skeletonized. These remains include a complete skull, including both the mandible and the cranium, with a disarticulated right temporal. One right side fragment of the sphenoid and one occipital fragment are also present. The maxillary dentition present on the right side includes the second molar and the third molar, which is present but damages to the teeth only allow for observations. The maxillary dentition on the left side includes the second molar and both the second premolar and the canine are present. The mandibular dentition present includes the left first incisor, second incisor, canine, first premolar, second premolar, first molar and the third molar. The right mandibular dentition present consists of the first incisor, second incisor, canine, first premolar, second premolar, and first molar.
Postcranial bones present include the right and left clavicle, the right and left scapula which are fragmented with one large scapula fragment, and the sternal body not including the manubrium. Only two cervical vertebrae are present, the atlas (C1) and one from C3-C6. There are four thoracic vertebrae present T1, 6 from (T2-T9), either T10 or T11, and T12. All five lumbar vertebrae are present. The left ribs present are first, second, one of ribs 3-10, and six body fragments. The ribs present on the right side are the first, second, three of ribs 3-10 and seven body fragments. The right and left humeri, radii and ulnae are included. The right first, second, fourth, and fifth right metacarpals are present. The bones of the left hand include: trapezoid, capitate, hamate, trapezium, and all five metacarpals. Nine unsided hand phalanges are also present. From the hip and leg there are fragments from the right and left os coxae, a fragmented sacrum, right and left femur and tibia, and seven fragments of the fibula present. The bones of the right foot present are talus, calcaneus, navicular, cuboid, medial (1st) cuneiform, and intermediate (2nd) cuneiform, as well as the first metatarsal with the proximal and distal phalanges of the hallux (known in common terms as the big toe), and the second and third metatarsals. The bones of the left foot present include talus, calcaneus, navicular, cuboid, medial (1st) cuneiform, lateral (3rd) cuneiform, first metatarsal with a proximal phalanx of the hallux, fourth metatarsal, and two broken metatarsals.

Also present are one unidentified articular facet and one unsided rib fragment. There are also associated cultural materials found with the skeletal remains that include wood, nails, cloth and dirt. The remains described above and laid out in anatomical position can be viewed in Figure 1A.
Figure 1: Anatomical Position (Full View)
Methods

Due to the poor condition in which these remains were recovered from the site not all available methods were viable. The bones that are present and the extent of deterioration and fragmentation on each given bone, dictated which methods were applied during this analysis.

One of the first determinations anthropologist attempt is sex of the individual. There are various methods that can be applied to determine the answer. The results are more accurate when confirmed by multiple distinct methods as some may result in ambiguous or contradictory results.

In this analysis Phenice’s (1969) visual method of sexing using the os coxae was applied. He developed this method of visually sexing the os coxae with the goal of accuracy, timely manner, and objectiveness, and it does not require years of experience for correct application (Phenice, 1969). Using this method three main characteristics need to be present to indicate female sex: the ventral arc, subpubic concavity, and a narrow, ridged ischio-pubic ramus. To assess presence of the ventral arc the observer must orient the pubis so that the ventral surface is directly in line of sight, and the pubic symphysis is in an anterior-posterior position (Phenice, 1969). According to Phenice’s (1969) description, “the ventral arc is an elevated ridge of bone which extends from the pubic crest and arcs inferiorly across the ventral surface to the lateral most extension of the subpubic concavity where it blends with the medial border of the ischio-pubic ramus (298).” The subpubic concavity can be identified by examining the dorsal aspect of the pubis and ischio-pubic ramus so the viewer may see a lateral recurved a short distance below the lower margin of the pubic symphysis, this feature is absent in males (Phenice, 1969). However some males might show a slight lateral recurve, but it is difficult to mistake this for the well defined curvature in the female. The last criteria in Phenice’s (1969) visual sex classification is the medial aspect of the ischio-pubic ramus. Male pelvis exhibit a broad flat surface while the
female pelvis has a ridge present and is slightly thinner (Phenice, 1969). Phenice emphasizes that serious reliance should only be placed on this feature in the absence of being able to examine the previous two techniques. He also stresses that these visual approaches are only valid on adult material and are not dependable to apply to sub-adult remains (Phenice, 1969).

Bass (2005) states that visual assessment of the skull is the second best option to use in sex determination. Using the skull for analysis, sex determination is based on the generalization that males are more robust and have larger muscle attachment sites than females. Even while this information may hold some truth, absolute distinctions rarely exist, in reality many intermediary features are seen. Nevertheless, there are some distinguishing characteristics that when all taken into consideration can provide an assessment of sex. Bass (2005) lists these features starting with the face as males having more prominent supraorbital ridges than females, sharp upper edges of the eye orbits in females and blunt in males, on average the palate is larger in males, and teeth are also often larger in males. Differences can also be found on the mandible. Generally the chin is more square shaped in males and tends to be rounded with a pointed midline in females (Bass, 2005). The mandibular teeth in males also tend to be larger than females.

Bass (2005) also catalogs male/female variation of the cranium. On average, the female skull is smaller and more gracile with frontal and parietal bossing that is common in childhood. On the occipital, muscle attachment sites, in particular the nuchal crest, is larger and more defined in males. The posterior zygomatic process extends past the external auditory meatus in males. The mastoid processes are normally larger in males, along with larger frontal sinuses (Bass, 2005).
Age estimation also has several methods that can be applied to determine the age at time of death. The more methods applied to the individual, the more one can narrow down the age range and have greater confidence in the resulting range. Applying the various methods as, with any method, depends on the bones available and the condition of those remains.

The pubic symphysis is one region used to determine age of an individual. There are several researchers who have provided methods for establishing age from this portion of the skeleton. The Suchey-Brooks method (1990) was applied to this individual because their method has been acknowledged as a reliable technique and the University of Montana Physical Anthropology Laboratory has three dimensional cast replicas that can be compared to the fragmented remains of UMFC #12.

The symphyseal face of the pubis, which is the surface where the pubis bones connect together, undergoes changes over the time period of the individual’s life. The surface of the pubic symphysis in early adulthood is very rough, with many ridges and deep furrows. Gradually, the furrows fill to create a smooth surface and a ridge on the outer, ventral surface forms (Ubelaker, 1999). After the surface smooths out and the ridge is completely formed, a rim of bone appears along the outer circumference of the pubis and then lastly, the symphyseal face of the pubic starts to deteriorate (Ubelaker, 1999). These changes are broken down into separate phases for males and females, as these rates may not be the same for the different sexes. So when this method is applied, it is important to have already determined sex of the individual to provide the most accurate results possible.

Although not nearly as accurate, cranial suture closure can also be observed and used to determine age at time of death. Suture closure usually begins endocranially and then progresses ectocranially. Ubelaker (1999) describes sutures as the lines between the twenty two bones
forming the skull. In younger individuals these sutures are clearly visible and over the life of the individual they gradually fade as the bones fuse together. In older individuals they can completely blend together so that they are obliterated (Ubelaker, 1999).

In 1985, Meindl and Lovejoy conducted a study on suture closure involving 236 crania of known age at time of death in the Hamann-Todd Collection in Cleveland, OH to improve the accuracy of cranial suture closure as a way to estimate age at death (Ubelaker, 1999). During their research they found that lateral-anterior sutures are more reliable than sutures of the vault. They also discovered that cranial suture closure to be similar for individuals of difference sex and ancestry. The Meindle and Lovejoy (1985) method involves ten cranial suture closure sites and four stages of closure. The sites are divided into two separate groups: vault sutures and lateral-anterior sutures. The four stages of closure are: open (no evidence of ectocranial closure), minimal closure (ranges from single bone bridge across the suture to 50% closure), significant closure (some portion of the suture remains incompletely fused), and complete obliteration (Meindle and Lovejoy, 1985).

Another method for estimating age at time of death applied to these remains involves the degenerative changes to sternal rib ends. In 1984, Iscan, Loth, and Wright examined 230 right fourth ribs removed during autopsy from Caucasian individuals of known sex and age for their research (Ubelaker, 1999). The articular surface is viewed and categorized based on degenerative changes to the sternal rib end face and rim, and classified into one of the Phase’s 0-8 with each phase associated with an age range (Iscan et al, 1984). This method is also split into male and female categories, so it is more dependable if the remains are already sexed.

While methods for estimating age and sex have been accepted as reliable and accurate, gauging ancestry is more difficult. An individual’s heritage is called many terms, for instance
cumulative affiliation, ancestry, and race. Some terms are more politically charged than others. Whatever term is chosen, it is a biological and cultural concept that covers a wide variety of aspects, such as skin pigmentation, geological origin, nationality, ethnicity, and other differences. Burns (2007) describes the confusion caused by this concept stating that biological information is complicated by the reality that there are no real racial boundaries. In fact, Burns (2007) states that human biological variation can actually be greater within a given ancestry than between different ancestries.

Although this concept is widely conflicted this information can be greatly valuable, therefore anthropologist attempt to classify skeletal remains ancestry. For undertaking this categorization Bass (2005) suggests cranial traits as being the most reliable method. Some key cranial features that help determine ancestry are: nasal region, eye orbits shape, skull vault shape, and the presence or absence of facial prognathism. In the nasal region the observer needs to focus on nasal with, nasal root, and the presence or absence of a nasal sill. FORDISC 3.0 (Jantz and Ousley, 2005) also attempts to assign ancestry based on cranial measurements. They have specific cranial markers that the distance between these points are measured and then entered in their database of know cranial measurements for difference ancestral populations and attempts to classify the given measurements into the closest matching group.

Anthropologists also try to determine stature from human remains. The most reliable bones for estimating living stature are the long bones of the skeleton. Formulas have been established by measuring remains of individuals with known living heights, sex and ancestry. It is important to establish sex and ancestry estimations before attempting to calculate stature, since the formulas differ based on these categories.
Biological Profile

Sex

It is a well accepted fact that the innomates provide the most reliable standard for the estimation of sex. According to Phenice (1969) there are two categories for sex determination. The first category is visual, which is based on morphological observations of the os coxa such as the greater sciatic notch, the width of the pubis, and the pre-auricular sulcus. The visual characteristic can be highly accurate when employed by a trained individual and can result in ambiguous findings when used by individuals without years of training (Phenice, 1969).

Secondly, measurements of the ischium-pubis are used in classification that can result in an accuracy of over 90 percent. However, there are two problems with this method. The major one being that the method requires the presence of most of the bone, which, depending on age and preservation can present a problem. The second issue is that the measurement procedure takes time, which noticeably prolongs the process when assessing multiple remains.

Due to these issues, Phenice developed a new method of sexing which had the accuracy and objectivity of the ischium-pubic index but did not require time consuming measurements and not all of the bone had to be present. He developed a fairly reliable visual method of determining the sex of an individual using the presence or absence of the ventral arc and subpubic concavity, and evaluation of the medial aspect of the ischio-pubic ramus. The ventral arc in female pubic bones have a slightly elevated ridge of bone which follows the pubic crest and curves inferiorly across the ventral surface to the lateral most extension of the subpubic concavity (Phenice, 1969). Males usually do not have a ventral arc and only in rare cases do they exhibit a slight ridge that should not be confused with the pronounced female ridge. In females the subpubic concavity, as described by Phenice (1969), is “a lateral recurve which occurs in the ischio-pubic ramus (300).” On the other hand, males might show an insignificant suggestion of a subpubic
concavity but not to an extent that it may be confused as a female trait (Phenice, 1969). On a female os coxa, a ridge can be observed on the medial aspect of the ischio-pubic ramus while in a male it a relatively flat, broad surface.

For UMFC #12 the os coxae are broken and missing the ischium and most of the pubis bone. The poor preservation condition of the os coxae, as seen below in Figure 2 shows the difficulty faced in using the most reliable bones of the skeleton to determine sex. However, the portions of the os coxae present are consistent with Phenice (1969) male classification. Examining the fragments present of the right os coxa there is no ventral arc present, and no pubic concavity is present. While the previous two traits are harder to determine due to the preservation and breakage issues, the medial aspect of the ischio-pubic is very clear in its broad flat surface as a male feature. Additionally the greater sciatic notch is present and is relatively narrow which is also consistent with male attributes (Bass, 2005).
The skull also displays moderate male characteristics, such as a nuchal crest, relatively large mastoid processes, a visible supraorbital margin, large glabella region, and a larger mental eminence. Also indicative of a male individual is a gonial angle that forms a right angle, moderately pronounced suprameatal crest, and a sloping frontal. These features are consistent with male morphology as described in Bass (2005).

However, the measurement of the maximum diameter of the head of the femur is somewhat contradictory to the previous visual results of the cranium and os coxae. Both the right and left maximum head diameter are 43mm which is within the range given for probably female ranging from 41.5mm to 43.5mm (Bass, 2005).

Twelve craniometric variables were entered into FORDISC 3.0 (Ousley and Jantz 2006) and compared to all sample populations available of both males and females, UMFC 12 was classified as a white male with a posterior probability of 0.602 and a typicality probability of 0.728. Entering twenty-eight postcranial measurements into FORDISC 3.0, UMFC was again classified as a male with a posterior probability of 0.647 and a typicality probability of 0.549. These results can be seen below in Table 1: FORDISC 3.0 Classification.

**Table 1: FORDISC 3.0 Classification of Sex**

<table>
<thead>
<tr>
<th>Group</th>
<th>Classified Into</th>
<th>Distance From</th>
<th>Posterior Probability</th>
<th>Typ F</th>
<th>Typ Chi</th>
<th>Typ R</th>
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<td>9.1</td>
<td>0.602</td>
<td>0.728</td>
<td>0.696</td>
<td>0.691</td>
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<td>0.66</td>
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<td>0.433</td>
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<tr>
<td>AF</td>
<td></td>
<td>16.4</td>
<td>0.015</td>
<td>0.645</td>
<td>0.173</td>
<td>0.103</td>
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<tr>
<td>JM</td>
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<td>0.23</td>
<td>0.163</td>
<td>0.095</td>
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<tr>
<td>BM</td>
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<td>0.143</td>
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<td>0.008</td>
</tr>
</tbody>
</table>

Current Case is closest to WMs

14
In conclusion of all the methods applied in determining the sex of this individual, the results are most consistent with that of a male. The contradictory result from the femoral head diameter may be a result of a small male which can coincide with end range on the probably female category as determined by Bass (2005). While Phenice’s (1969) visual method of sexing the os coxae, Bass’s (2005) visual cranial characteristics, and FORDISC 3.0 measurements all produce a uniform answer of male.
Age

The estimation of age at time of death is based on observing morphological changes in the skeletal remains, comparing the variations to known ages of similar populations, while also taking into consideration any source of variability that might exist between the unknown remains and the known sample comparison (Ubelaker, 1999). Determining age is based upon known chronological changes in the skeleton. From birth to approximately twenty years of age these changes involved bone growth, epiphysial closure, and teeth eruption (Ubelaker, 1999). Around the age of twenty most bone growth and dental eruption is completed and then age must then, from that point on, be determined from degenerative changes in the skeletal structure. Figure 3 shows the cranium and ribs present and the poor preservation condition these bones were in which increased difficulty in applying aging methods.

Several methods of age indicators were applied in order to estimate age at death for UMFC 12. Using the Suchey-Brooks method (1990) to each partial pubic symphysis resulted in a Phase 2 classification with a corresponding age range of 19 to 34 years. Meindl and Lovejoy’s (1985) cranial suture closure gives an age range of 28 to 54 years. The vault composite score of nine provided an age range of 28-44 years and the lateral-anterior composite score of six supplied a range of 29-54 years. The palatine sutures were not completely obliterated but the incisive and posterior median palatine suture were over 50% fused, which is consistent with a young to middle aged adult with an age range of 20 to 50 years.

The method of Iscan, Loth and Wright (1984) was applied to the 4th right rib and the 3rd left rib and they were both scored as a Phase 3 and/or 4 with an age range of 24-32 years. Phase 3 and/or 4 is described as a deepening V-shaped concavity on the sternal rib end, with less
regular edges (Iscan et al, 1984). The center of the flat edges also project outward and there is a loss of wavy surface on the face of the sternal rib end.

Taking into account the lack of any arthritic degenerative changes suggests an individual under forty. Collectively these age indicators are consistent with a young to middle aged adult likely between the ages of 19 to 34 years. This age range differs significantly from Dr. Smith’s analysis in 1983 and I believe this is due the advances in research on estimating age. Some of the methods that were applied in this analysis were not available at the time of Dr. Smith’s evaluation. In addition, these more recent methods have been determined to be more reliable in estimating age than some of the methods she used in her initial investigation.

Figure 3: Upper Skeleton (Superior View)
Dentition

The maxillary dentition present on the right side includes the second molar and the third molar, which is present but damage to the crown only allows for limited observations, as shown in Figure 4B. The maxillary dentition on the left side includes the second molar and both the second premolar and the canine are present but damages only allow for minimal observations and no measurements can be taken. The mandibular dentition present includes the left first incisor, second incisor, canine, first premolar, second premolar, first molar and the third molar, as seen below in Figure 4A. The right mandibular dentition still present consists of the first incisor, second incisor, canine, first premolar, second premolar, and first molar.

On the mandible the second right molar, along with the second and third left molars were lost ante-mortem with significant re-absorption of the crypts. The maxillary right and left first incisor and the left second incisor were lost post-mortem. While the left first and second molars, and the right second incisor, canine, first and second premolars, and third molar were all lost ante-mortem with re-absorption of the crypts present.

The teeth are free of hypoplastic lines, pipe facets, and staining. Two teeth are affected by carious lesions. The right maxillary second molar is affected by an interproximal surface cavity and the right mandibular first molar is affected by an interproximal and occlusal surface lesion. There is a possibility that this individual suffered from periodontal disease. Overall the molars present shows little wear with only small wear facets. The premolars have slightly more wear with moderate dentin patches, and the canines and incisors exhibit the greatest wear.
Figure 4A: Mandibular Dentition  
Figure 4B: Maxillary Dentition
Ancestry

The question of ancestry, based solely on skeletal remains of a given individual, is one of the most difficult to answer for anthropologists. According to Bass (2005) the skull is the only reliable region of the skeleton from which an accurate evaluation of cultural origin can be acquired. However the research on anterior femoral curvature and the torsion of the femoral neck states that they may also be used as a possible indicator of ancestral association. This method of femur visual classification is considered less reliable according to Bass (2005). There are two main methods to determine ancestry from the skull: morphological assessment of the face and vault, and craniometric measurements (Bass, 2005).

Figure 5: Cranium (Frontal View)

Visual cranial traits present in UMFC 12, as depicted in Figure 5, can be described as a high nasal root, tall and narrow nasal aperture, sharp inferior nasal border with a pronounced nasal spine, and generally narrow facial breadth. Overall the facial profile is flat with very slight alveolar and midfacial prognathism. The maxillary palate is parabolic in shape and the mandibular incisors are spatulate in appearance. The eye orbits are angular in shape and the vault sutures are moderately complex. The femur shaft is curved and the femoral neck has mild
torsion. This pattern of craniofacial and femoral morphology is consistent with individuals of European ancestry (Bass, 2005).

Using sixteen cranial measurements, FORDISC 3.0 classifies UMFC 12 as “White” with a posterior probability of 0.904 and a typicality probability of 0.787. Table 2 depicts FORDISC 3.0 results when only males are selected, since in the sex category these remains were determined to be most consistent with that of a male.

**Table 2: FORDISC 3.0 Classification of Ancestry**

<table>
<thead>
<tr>
<th>Group</th>
<th>Classified Into</th>
<th>Distance From</th>
<th>Posterior Probability</th>
<th>Typicality</th>
</tr>
</thead>
<tbody>
<tr>
<td>AM</td>
<td></td>
<td>34.9</td>
<td>0</td>
<td>0.381</td>
</tr>
<tr>
<td>BM</td>
<td></td>
<td>23.6</td>
<td>0.007</td>
<td>0.932</td>
</tr>
<tr>
<td>CHM</td>
<td></td>
<td>34.3</td>
<td>0</td>
<td>0.067</td>
</tr>
<tr>
<td>GTM</td>
<td></td>
<td>31.5</td>
<td>0</td>
<td>0.133</td>
</tr>
<tr>
<td>HM</td>
<td></td>
<td>18.5</td>
<td>0.089</td>
<td>0.846</td>
</tr>
<tr>
<td>JM</td>
<td></td>
<td>28.9</td>
<td>0</td>
<td>0.112</td>
</tr>
<tr>
<td>VM</td>
<td></td>
<td>41.1</td>
<td>0</td>
<td>0.095</td>
</tr>
<tr>
<td>WM</td>
<td><strong>WM</strong></td>
<td>13.9</td>
<td>0.904</td>
<td>0.787</td>
</tr>
</tbody>
</table>

Current Case is Closest to WMs
Stature

The most reliable way to estimate stature is to take measurements from intact long bones. A height range can then be calculated based on the correlation between body height and limb length (Ubelaker, 1999). However it is necessary to first determine sex and ancestry as there is considerable variation among different populations in the ratio of long bone length to stature (Ubelaker, 1999).

Using FORDISC 3.0 the mean stature and range is calculated based on a 19th Century reference sample of white males of known height. Table 3 depicts the range for each bone measure for this individual is shown below. The estimated stature is derived from the maximum length of the all bone measurements because it has the smallest error range. The calculated mean is 65.5 inches plus or minus 1.9 inches, with a 90% probability interval of 63.6 to 67.4 inches. This individual was probably in the range of 5’2” to 5’8” in height.

Table 3: Stature Estimation Chart

<table>
<thead>
<tr>
<th>Stature Estimation: UMFC 12</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>19th Century White Male</strong></td>
</tr>
<tr>
<td>Clavicle (Right)</td>
</tr>
<tr>
<td>Humerus (Right)</td>
</tr>
<tr>
<td>Radius (Right)</td>
</tr>
<tr>
<td>Ulna (Left)</td>
</tr>
<tr>
<td>Femur (Left)</td>
</tr>
<tr>
<td>Tibia (Left)</td>
</tr>
<tr>
<td>Calcaneus (Right)</td>
</tr>
<tr>
<td>Clavicle &amp; Calcaneus</td>
</tr>
<tr>
<td>Humerus, Radius, &amp; Ulna</td>
</tr>
<tr>
<td>Femur &amp; Tibia</td>
</tr>
<tr>
<td>All Bone Measurements</td>
</tr>
</tbody>
</table>
Taphonomic Alterations

There are no obvious signs of antemortem or perimortem trauma present on the remains of this individual. However, there is considerable postmortem breakage. The skull has extensive postmortem breakage to the right side. The right temporal has been disarticulated (Figure 6), and the bone has warped on the right side. There are also multiple linear scrape marks on the right parietal. There is postmortem breakage to the long bones, os coxae, sacrum, ribs and the thoracic vertebrae.

Figure 6: Disarticulated Right View of Cranium
**Preservation Assessment**

Since these remains are consistent with a historic burial and at the time of recovery only wood fragments and nails remained of the coffin the individual was buried in, it is reasonable to assume that the bones suffered preservation issues. The bones have been stained from an extensive period of being directly exposed to minerals and soil. There is also noticeable root markings and postmortem breakage.

The remains of the case labeled UMFC #12 stored in the locked Physical Anthropology Laboratory at the University of Montana have noticeable degrees of corrosion presents. The skull, including the left frontal and the right occipital, has the most extensive deterioration present. The preservation condition can be categorized as Behrensmeyer’s (Buikstra & Ubelaker, 1994) Stage 3, which is described as patches of rough compact bone resulting in fibrous texture. The mandible and postcranial bones fit into Stage 2, which is expressed as thin layers of bone that show flaking usually associated with cracks on the surface of the bone.

The fragile skeleton of UMFC #12 illustrates poor preservation and deterioration, which are illustrated with Figure 7A and 7B. The majority of the remains show deterioration of cortical bone to the underlying cancellous or spongy bone. This extensive corrosion indicates that these remains have been exposed to acidic soil and/or water. The bones are also affected by varying colors of mold spores, from green, white, and black. The presence of mold implies that this individual’s remains were exposed to a moist environment and may even suggest a burial time frame. The mold spores are even located inside the cranium as well as the entirety of bones present. Overall the remains are an uneven brownish color with small black, white, and green spotting.
Figure 7A: Cranium (Left View)  
Figure 7B: Shoulder Region (Right)
**Pathological Conditions**

There is no trauma present. However, this individual has several pathological conditions affecting the remains. On the medial aspect of the proximal end of the right humerus there is a large undetermined bone abnormality present (Figure 8A). After in-depth consultation with Dr. Walter Kemp, a forensic pathologist and the Deputy Medical Examiner at the Montana State Crime Laboratory, it has been determined that the bone irregularity is an unidentified infiltrative process, consistent with a benign bone tumor. This was determined using x-rays (Figure 8B) which showed no noticeable difference in the cortex of the bone and by taking a bone sample and viewing it under a microscope. The slide, containing a small sample of the affected bone, showed the medullary cavity intact and no destruction of the trabeculi as is common in cancerous bone tumors.

![Figure 8A: Humeri](image1.png)  ![Figure 8B: Humeri X-Ray](image2.png)

Also exposed by x-rays are linear striations on the distal ends of the humeri (Figure 9). These are sometimes referred to as transverse or Harris lines, which are usually the result of instability during bone growth, such as ingestion of harmful substances, dietary deficiencies, or illness (Hughes et al, 1996).

“Current theory suggests that transverse lines are formed in long bones when cartilage growth is interrupted in an epiphyseal plate but osteogenesis continues in the adjoining bone.”
end of the diaphysis. When the epiphyseal plate begins to grow again, it does so slowly at first, so that bone deposition in the diaphysis continues to outpace longitudinal bone growth for a time, resulting in a thickening of the zone of high-density bone (123).”

There have been many additional studies into this phenomenon since Harris’s initial studies in the 1920s. Some longitudinal studies have revealed that line formation is at a high during the second and third years of life and typically decline after five years of age (Hughes et al, 1996). Research was also directed into the effect of diet on line development and explained that nutritional levels alone did not determine the vulnerability to line formation. However, it does factor into the speed with which children recovered from metabolic disorders (Hughes et al, 1996). These studies also suggested that the presence of the lines may be due to cortical thinning which allows for lines to be observed more easily.

Another interesting piece of information obtained by Harris line studies is that these lines are symmetrically formed across the skeleton, especially at the more rapidly developing ends of the long bones. Also discovered is that lines may disappear over time due to growth and bone remodeling (Hughes et al, 1996). Disruptions that cause the formation of these lines can range from infection to food deficiency, or even physical stress. The lines are actually consequences of growth recovery in the affected individuals (Hughes et al, 1996).
It is possible that this individual also had a pathological condition that affected the alveolar bone, such as a severe case of periodontal disease. There is missing bone in the alveolar region of the maxillary and a majority of the teeth have been lost and the crypts are either reabsorbed or in the process of being reabsorbed.

While a sternal foramen (Figure 10A) is not a pathological condition it is still interesting to note in this individual.

Figure 10A: Sternal Foramen  Figure 10B: Endo-cranial Pitting

On the inside of the cranium on the frontal bone are depressions with pitting. The depressions and pitting are larger and more noticeable on the left side of the frontal than the right, but are present on both sides (Figure 10B).

In the superior aspect of the eye orbits there is pitting present, known as \textit{Cribrar}\textit{Orbitalia}, which is assumed to be associated with anemia or a nutritional deficiency in an individual’s diet, shown in Figure 11A and Figure 11B. Pitting is also found on the cranial vault along the sagittal and coronal suture, which is commonly known as \textit{Porotic Hyperostosis}.
Figure 11A: Orbital Roofs (Superior View)  Figure 11B: Left Orbital Roof
Associated Cultural Artifacts

Along with the skeletal remains some associated cultural artifacts were also recovered from the site. These artifacts included wood fragments with nails embedded and five small glass fragments (Figure 12C). Associated cultural artifacts can, in some cases, be used to provide an accurate time frame of death. Nails are commonly recovered artifacts at site and due to this frequent occurrence archaeologist have turned to them as a dating tool. Recently the Louisiana Nail chronology has been developed and based on twelve basic types of nails (Wells, 1998). The twelve nail types are based on the structure and physical features following technological developments across the history of nail manufacturing.

These nails suffer from extensive corrosion due to poor preservation conditions (Figure 12A and Figure 12B). After bringing them to the attention of Dr. John Douglas, a professor in the Anthropology Department at the University of Montana who specializes in archaeology, he believes that they can only be described as machine made nails, as opposed to handmade nails. This distinction gives a very wide date range, as machine made nails begin being produced in the late 18\textsuperscript{th} century (Wells, 1998).

Figure 12A: Nails in Wood  Figure 12B: Single Nail  Figure 12C: Glass Fragments
Literature Review

In ancient human skeletal collections, porotic hyperostosis and cribra orbitalia are the most frequently observed pathological lesions (Walker et al, 2009). The term porotic hyperostosis was coined by Angel in 1966 and refers to a condition characterized by lesions commonly found on the ectocranial surface of the parietal and occipital bones of the cranium (Keenleyside and Panayotova, 2006). Porotic hyperostosis can be described as small punctures in the outer surface of the cranial vault, usually found near the sutures. These lesions emerge as regions of porous and thickened bone resulting from hypertrophy of the diploe, thinning of the outer cortical bone, and exposure of the inner trabecular bone (Keenleyside and Panayotova, 2006). Pitting on the roof of the eye orbits is called cribra orbitalia. These lesions, and others, are created by the expansion of the diploe or spongy bone of the skull in reaction to marrow hypertrophy (Walker et al, 2009). While the precise quality of the relationship between porotic hyperostosis and cribra orbitalia is ambiguous, investigation indicates that the two conditions are related and that cribra orbitalia corresponds to the preliminary state of the disease progression (Keenleyside and Panayotova, 2006). Other pathological conditions that also can produce porosities in the external surface of the cranial vault are associated with chronic scalp infections and scurvy.

The remains of prehistoric and historic individuals discovered by bioarchaeologists have exhibited these lesions and typically use their presence in assessing the health and nutritional status of the past populations. In the 1950’s an iron-deficiency anemia theory was proposed and widely accepted as the origin of the marrow hypertrophy that produces porotic hyperostosis and cribra orbitalia (Walker et al, 2009). This theory is based on correlations with modern clinical cases in which hematological evidence of iron-deficiency anemia and radiographic evidence of
cranial vault marrow hypertrophy occur simultaneously (Walker et al, 2009). Studies of epidemiological data have also been used to support the iron-deficiency anemia theory.

The widespread occurrences of porotic hyperostosis and cribra orbitalia in archaeological collections suggest a correlation with the widespread nature of iron deficiency anemia affecting many populations. An estimated 500 million to 600 million people in developing countries are affected by iron deficiency anemia, a worldwide health problem associated with poor living conditions such as inadequate sanitation, diets deficient in vital nutrients, and infectious disease (Walker et al, 2009).

In an article by Nancy Lovell (1997) anemia is seen as a widespread health problem that can be described as red blood cells deficiency, with the most severe forms being genetically inherited and the most common is acquired through malnutrition. Once the iron stores have been depleted from the body, the bone marrow is forced to increase red blood cell production and this compulsory response can be seen manifested in the skeleton (Lovell, 1997). This reaction causes visible pitting of the external surfaces of the cranial vault and the orbital roofs, which is a reaction to hyperplasia of the marrow (Lovell, 1997).

According to Lovell’s (1997) research, lesions of the roof orbits are most pronounced and frequent in infants and children, developing as early as six months of age. Cranial vault lesions have also been known to emerge as early as six months, but are more likely to be observed after five years of age (Lovell, 1997). An identification of acquired iron-deficiency anemia can be determined because skeletal changes are usually minor and localized, as seen when the porotic lesions and diploe thickening of the cranial vault and roofs the eye orbit (Lovell, 1997). Acquired iron deficiency anemia, as stated by Lovell (1997), may result from dietary shortages of ingestion or absorption. On the other hand, due to the severe health consequences of genetic
anemia one might assume that the condition would be eradicated from the gene pool through natural selection. However, the beneficial nature of the heterozygous expression of this condition aids in the survival of populations in prevalent malaria regions (Lovell, 1997).

In a study by Keenleyside and Panayotova (2006), they research the claim that cribra orbitalia and porotic hyperostosis found in skeletal remains of malaria prone regions are a result of genetic anemia, specifically thalassemia, more commonly known as sickle cell anemia. Specifically this study focused on cribra orbitalia and porotic hyperostosis in Greek skeletal remains. These conditions, when discovered are typically attributed to a genetically acquired anemia known as thalassemia due to the presence of endemic malaria in the Mediterranean region (Keenleyside and Panayotova, 2006). The researchers examined a total of 184 intact skeletons, in which they discovered significantly higher frequencies of cribra orbitalia in subadults compared with adults. These findings are consistent with other studies and reflects the notion that greater iron intake is required during the growth period (Keenleyside and Panayotova, 2006). They also assert that it is complicated to differentiate between an acquired and genetic anemia when the two forms coexist in a given location. An acquired anemia is more frequent and due to its common nature it is more likely to cause the lesions found in skeletal remains recovered (Keenleyside and Panayotova, 2006).

In their conclusion, Keenleyside and Panayotova (2006) warn again interpreting porotic hyperostosis and cribra orbitalia as evidence of iron deficiency anemia, stating that the lesions present on the remains may in actuality be indicative of other metabolic disorders such as rickets and scurvy. Survey manifests itself in the bone with porosity of the maxillary and sphenoid bones, and the researchers argue that it is probable that cases of scurvy and rickets have been misdiagnosed as anemia in skeletal remains (Keenleyside and Panayotova, 2006).
Due to historical records, it is known that scurvy was a common disease. In 1752, James Lind discovered and published his findings that a lack of fresh fruit and vegetables in the diet caused a vitamin C deficiency (Ortner et al, 2001). Scurvy is due to an insufficient quantity, or complete lack of, ascorbic acid commonly known as vitamin C, in the diet and in severe cases may result in the formation of porous lesions in the bone (Ortner and Ericksen, 1997). Even with the breakthrough in the 18th century, scurvy continued to plague populations when the nutritional quality of the food available was substandard, especially frequent in lengthy military campaigns (Ortner et al, 2001).

In an article by Tanya Peckmann (2003) the researcher suggests that porotic hyperostosis and cribra orbitalia might be a result of smallpox infections. While the primary agreement for these lesions is iron deficiency anemia, Peckmann argues that there are two categories that explain the lesions manifested on skeletal remains. One category being dietary and the other what the author terms the parasite model. Under the parasite category Peckmann (2003) claims that many pathogens, such as smallpox, requires iron to reproduce resulting in an iron deficiency.

Due to other pathological conditions that cause lesions in the skeleton it is essential to take a multifactorial approach to the analysis and interpretation of cribra orbitalia and porotic hyperostosis (Keenleyside and Panayotova, 2006). An approach that takes into consideration archaeological and literary sources for information on the lives of the population being studies, stable isotopic evidence of diet, and other skeletal indicators of physiological stress needs to be utilized to identify possible causes of iron deficient anemia (Keenleyside and Panayotova, 2006).

However, Walker and other’s (2009) article challenges the commonly accepted theory of iron deficiency anemia claim that “anemia’s causing premature red blood cell death and increased erythropoiesis, such as the megaloblastic and hemolytic anemias, provide a much more
likely explanation for porotic hyperostosis than does iron-deficiency anemia (page 109).”

Although they do clarify that cribra orbitalia may also be caused by megaloblastic and hemolytic anemia, their research suggest that these lesions have a more complex etiology that on occasion includes the subperiosteal bleeding connected with nutritional deficiencies (Walker et al, 2009).

In another study by Wapler and others (2004) they also contest the anemia theory stating that “recent investigations showed that in some cases, the histologic bone structure does not support the diagnosis of anemia (Wapler et al, 2004, page 333).” Due to this information they carried out studies of orbital roof lesions in 333 Nubian remains from northern Sudan. They found that 56.5% of cribra orbitalia cases exhibited no histologic features demonstrating variations due to anemia (Wapler et al, 2004). Implying that over half of the individuals displaying cribra orbitalia apparently were not anemic, indicating that the lesions are not necessarily indicative of anemia. Due to this information it can be concluded that the high frequencies of these lesions are not a reliable measure of the impact of diseases which lead to anemia (Wapler et al, 2004). In their skeletal sample porosity was not always systematic with pathological changes. Actually, when macroscopic analysis was preformed showed postmortem destruction and taphonomic alterations, such as desert sand erosion, contributed as much as 20% to the findings of lesions on skeletal remains.

A further obstacle in determining what causes the porous lesions regularly found on archeology skeletal remains is not only that there are several diseases that cause lesions, which are hard to distinguish between, but also that more than one disease may be found in the same individual. For instance, scurvy is known to occur with rickets and acquired anemia is also associated with scurvy and thought to be caused by iron deficiency increased red blood cell turnover and blood loss through defective blood vessels (Ortner and Ericksen, 1997). These
concerns need to be cautiously contemplated and additional research on anemia, infections, and
diseases in archaeological human skeletons is required to be able to better determine what is
responsible for the conditions found in skeletal remains.
Conclusions

After thorough examination the remains are most consistent with an adult Caucasian male individual of between the ages of 19 to 34 years old, with an approximate height of 5’2” to 5’7”. There appears to be some pathological abnormality affecting the cranium and the right humerus. No obvious antemortem or perimortem trauma is visible on the remains, but there is extensive postmortem breakage. The noticeable staining and poor preservation present on the skeletalized remains would indicate that these remains are not recent. It is possible that these remains could be historic, most likely pre 1900’s. Additional data, such as other datable associated artifacts or association with datable natural or cultural features, would be needed to suggest a narrower time since death.

While this case is not considered a forensic case based on the information that this individual was recovered from what is consistent with a culturally appropriate burial, with a wood coffin and no apparent pre-mortem trauma. In addition, these remains have significant staining and overall deterioration which indicates that this is not a recent burial. Even though this is not a forensic case it illustrates the difficulty anthropology face in analyzing human remains. The small stature and ambiguous nature of key features that this individual exhibited illustrates the difficulties of determining sex and how important it is for anthropologist to learn and understand variability among human remains.
Bibliography


