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Shoe Modifications and Foot Health: A Case Study from Roman Britain

Casey Elizabeth Kay Boettinger, *Western University*

Supervisor: Greene, Elizabeth M., *The University of Western Ontario*

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Abstract

In this thesis, I undertake an examination of foot care practices in Antiquity. Most of the discussion surrounding foot care comes from evidence of shoe modifications at Vindolanda, a Roman auxiliary fort located in northern Britain. I provide a general discussion about herbal and non-herbal remedies for foot conditions, as recorded by medical authors. This discussion precedes a case study of selected shoes from Vindolanda, where I write about five modification types that demonstrate the sort of knowledge that existed at Vindolanda. The findings from this thesis suggest that podiatric knowledge and foot care existed as early as the Roman period, which is much earlier than previously thought. By studying a selection of shoes from this assemblage, I seek to add to the knowledge we already possess concerning foot health in Antiquity. While medical authors (Galen, Hippocrates, Celsus) did write about common foot concerns, evidence of shoe modifications at Vindolanda suggests that there was more known about treating foot conditions than was recorded in writing.

Keywords

Vindolanda, Roman army, Roman shoes, archaeological footwear, shoe modification, foot health

Summary for Lay Audience

In this thesis, I examine foot care practices in Antiquity. Most of the discussion surrounding foot care comes from evidence of shoe modifications at Vindolanda, a Roman auxiliary (military) fort located in northern Britain. I provide a general discussion about herbal and non-herbal remedies for foot conditions, as written by medical authors. This discussion comes before a case study of selected shoes from Vindolanda, where I write about five categories of shoe alterations that demonstrate the sort of knowledge that existed within the community at Vindolanda. The findings from this thesis suggest that knowledge of treatment for foot conditions and care existed as early as the Roman period, which is much earlier than previously thought. By studying a selection of shoes from this assemblage, I seek to extend the knowledge we already possess concerning foot health in Antiquity. While medical authors (Galen, Hippocrates, Celsus) did write about common foot concerns, evidence of shoe modifications at Vindolanda suggests that there was more known about treating foot conditions than their texts record.

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CHAPTER 1:
The Study of Roman Foot Health

1. Introduction

Health is a complicated topic which has been of interest to disciplines beyond the medical and health sciences, including anthropology, sociology, and arts and humanities fields such as philosophy and classics. In a historical context, it is impossible to assess the broad label "health" in a population with archaeological remains alone.[1] Fortuitously, at the classicist's disposal are writings from medical doctors such as Hippocrates or Galen, who wrote on a variety of topics surrounding health concerns and their treatments. Classical archaeologists weave together information from ancient texts with artefactual evidence to understand ancient attitudes surrounding health. Sometimes there may be medical writings that conflict with artefactual evidence, or artefacts that are not mentioned in texts. Bringing the two areas of study together may not produce a full picture of the past, but they can certainly complement each other.

When bioarchaeologists (sometimes called osteoarchaeologists) study the health of individuals at a site, they most often study the physical bodies of long-dead people: they analyze bones to answer questions about stature, age, sex, and what sort of diseases or maladies individuals faced during life. At Vindolanda, a Roman auxiliary fort located in northern Britain, there exists a unique opportunity to discuss the health

[1] The World Health Organization defines health as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity."

of the inhabitants through their shoes, rather than through an analysis of their bones. The preservation of thousands of shoes from the Roman period is all the luckier due to the lack of human skeletal remains from Vindolanda or from nearby sites in this historical landscape. Rather than studying bone wear to understand the types of walking conditions faced by these auxiliary soldiers, this thesis focuses on shoe soles from the Vindolanda assemblage.

This thesis specifically focuses on lower limb health as measured by gait wear and the shoe modifications that helped to correct how a person walked. Research into the shoes will be complemented by information from modern podiatry and a discussion of what ancient authors recorded about foot health. Due to a lack of context surrounding the ownership of the shoes, this thesis does not make assumptions about the owners' social characteristics; we cannot determine their status within the community nor other axes of identity other than their sex. It is only possible at this point to examine these shoes with the understanding that they belonged to individuals who were part of the military community at Vindolanda.

The assemblage of shoes used in this study provides detailed information about the military community at Vindolanda. First and foremost, the Vindolanda assemblage demonstrates that this community possessed techniques to mitigate gait issues and foot pain. The examples discussed here appear to be the earliest physical evidence of historical shoe modifications that resemble a modern practice of podiatry and foot care. These conclusions alone will be of immediate importance beyond Roman archaeology, particularly for researchers in other fields such as podiatry and pedorthy, kinesiology, physical anthropology and other fields with an interest in historical health issues. Secondly, the material discussed in this thesis adds another perspective to our understanding of ancient medical practices. The Vindolanda shoes are particularly important for adding to the corpus of archaeological evidence that moves research beyond evaluation of textual evidence and into the sphere of the actual physical remains of health care in antiquity. The case studies presented here represent only a fraction of the study possible and the Vindolanda assemblage holds further promise to illuminate our knowledge of foot health in antiquity.[2]

This chapter provides background information for the study of foot health and the study of archaeological footwear. In chapter two, a survey of the medical authors' writings is conducted, which focuses on what exists in the medical authors' corpus that deals with foot issues. Chapter two also considers the military community at Vindolanda and investigates how we can assess the standard of health and foot care in the Roman army. Chapter three introduces Vindolanda and its shoe assemblage. The case study begins by situating Vindolanda in the landscape of Roman Britain and explains the process used to determine the categories of shoe modifications at this fort. Chapter four is a discussion of the findings and what they suggest about the inhabitants at Vindolanda and the broader military community. Using information from modern podiatry, the thesis concludes that there were people living at Vindolanda who had knowledge of foot care that went beyond the poultices and pastes that the medical authors suggested for foot pain management. This thesis furthers the study of shoe modifications in use by the Roman auxiliary army of Vindolanda and the surrounding community.[3]

[2] See Appendix A for photos of each shoe used in the case studies and Appendix B for an Excel sheet containing information about each shoe: what period of occupation they came from, size, and assigned ownership (adult male, female/adolescent, child), among other collected data.
[3] Greene 2019 is the only other article that has referenced podiatric knowledge based on shoes from Vindolanda.

1.1. Research Aims

The aims of this thesis are two-fold. First, it seeks to establish the use of non-traditional sources to discern aspects of health in a population, specifically related to the lower limbs. Second, this thesis aims to further research efforts that demonstrate the podiatric knowledge that existed in the Roman world, as well as to investigate who had access to podiatric remedies. In a Classical context, the first sources that provided demographic information were those written by ancient authors. By studying what doctors such as Galen and Hippocrates wrote, researchers sought to reconstruct the health of the Roman population. These doctors wrote about issues that their patients faced, and thus, provide a starting point for health concerns in the past. In many classical contexts, bioarchaeologists today study the skeletal remains of individuals to better understand the issues that the medical doctors wrote about, as well as to understand the diets and lives of people in the past. At Vindolanda, there is no bioarchaeological dataset from which to study the fitness of the military community, which prevents any osteological investigation. As this thesis concerns itself with the field of archaeology, it is imperative to find other physical (non-literary) artefacts that can be used to determine health at Vindolanda. In short, the present thesis seeks to combine evidence from multiple sources, including texts, material culture, art, and the physical remains of shoes to create a more holistic understanding of Roman society.[4]

[4] Buck et al. 2019 takes a similar approach with skeletal material from Vindolanda, suggesting that studying a combination of texts, art, material culture, and skeletal remains offers a better understanding of the Romans.

1.2. Forensic Podiatry and the Foot in Archaeology

Forensic gait analysis today is a field of study which seeks to identify individuals based on the way they walk.[5] Forensic podiatrists analyse two or more sets of video footage to compare the gait of those walking to aid in criminal trials. Forensic gait analysts understand that footprints are much like fingerprints, in that each one is unique. They can, therefore, be used to determine important individualizing information about a person. Although dealing with dead populations, both bioarchaeology and forensic podiatry can use patterns of movement and wear to identify unique walking conditions. Methods from forensic gait analysis can be used to analyze wear marks and foot impressions on shoes since the way that a foot impresses on a shoe leaves distinct wear patterns.

In his PhD dissertation, Denis Vernon describes the utility of shoe wear analysis for predicting medical conditions such as Hallux rigidis, pronation, pes cavus and rearfoot varus.[6] He provides a brief history of shoe wear analysis, beginning with Schuster's 1914 and 1915 publications. In 1920, Ware related some patterns of wear with known foot conditions. Anthropological interest in these patterns of wear, however, did not begin until Louise Robbins' publications focusing on personal footprint and wear pattern theories.[7] William Bodziak provided the following definition of wear patterns: "The wear pattern or position of wear can be defined as an arrangement or pattern of wear characteristics that stands out against areas of relatively less or greater wear. The wear pattern is largely influenced by the shape, size, bone

[5] Macoveciuc, Rando, and Borrion, 2019.
[6] Vernon 2000.
[7] Robbins 1978; 1984; 1985; 1986.

structure and biomechanics of the wearers' feet."[8] The scientific study of wear patterns and foot conditions is still relatively new and had to become an established scientific study before the inception of the field of forensic podiatry.

C.H. Barnett and researchers undertook an experimental study of shoe wear to determine whether shoes are a reliable source of information to make determinations about the effects of locomotor disorder. They concluded that shoe wear analysis could provide reliable information about abnormal gait if all available evidence from the shoe was taken into account.[9] The plastic pedograph, the tool with which they conducted their case studies, measured only the length of each phase of gait, the duration of weight bearing during the stance phase, and the intensity of vertical forces during the weight bearing phase of walking.[10] Vernon, however, notes that the plastic pedograph did not measure forces such as friction, shear, or torsion, all of which may dictate wear on the outsole.[11] Though the execution of their idea had some flaws, the basic concept they were trying to determine, whether shoes are a reliable source of information to learn about someone's gait, does have merit.

A recent publication by Taylor Eagle seeks to analyze the origins of rheumatoid arthritis (RA) and establishes the issues with differential diagnosis of such conditions in the archaeological record.[12] Individual bones have also been studied: Mathew Teeter conducted studies on the first metatarsal (MT1) to determine if it was a viable option

[8] Bodziak 1990: 305-306.
[9] Barnett, Bowden, and Napier 1956.
[10] According to Vernon, the plastic pedograph consists of packed vertical Perspex rods on a rubber base. When pressed upon, the rods were filmed, and each frame was converted to a record which showed an outline of the shoe sole along with an index of the pressure applied during that time. More information about the plastic pedograph can be found in Vernon 2000: 12-15.
[11] Vernon 2000.
[12] Eagle 2021. RA has historically been difficult to assess in archaeological populations because of the poor preservation of hand and foot bones, the non-specific appearance of RA lesions on bones, and other biases that are inherent in the record.

for learning about human variation and bone health in antiquity.[13] Eagle's publication lists common forms of arthritis: rheumatoid, osteo, psoriatic, and gouty. In the final type of arthritis, she notes that the most commonly affected joints are those in the feet, hands, wrists, elbows, and knees. In 90% of all clinical cases, the first metatarsophalangeal joint is affected. With gouty arthritis, joints are affected asymmetrically, whereas with RA, joints are affected symmetrically.[14] In the absence of bones, a study of shoes may provide insight into the types of conditions faced by people in the past: individuals with arthritic feet may have benefitted from shoes with modifications pertinent to providing comfort for their condition.

Luís Marado and Jorge Ribeiro conducted a study using both footprints and shoe prints from brick workshops at *Bracara Augusta*.[15] Though they did not have physical bones to study, the footprints present on brick allowed them to estimate the sex, height, weight, and age of the individuals who left the prints. Their work is the first to use footprints and shoeprints in a Roman context to make such determinations. Their work is especially interesting because it highlights the variety of information that can be gleaned through a careful examination of imprints. Marado and Ribeiro's study of imprints is complementary to the work that will be undertaken in this thesis: it shows, yet again, that one can use shoes or shoe-adjacent material to write biological profiles for people from the past.

[13] Teeter 2017.
[14] Eagle 2021.
[15] Marado and Ribeiro 2018.

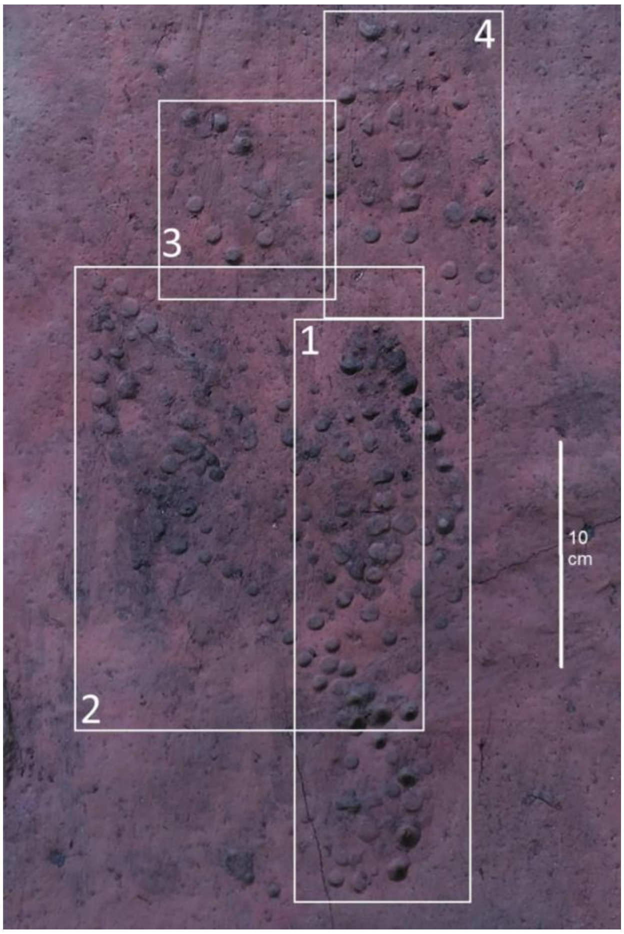

Fig. 1.1: Shoe prints from *Bracara Augusta.* The four boxes outline individual shoe prints. Image from Marado and Ribeiro 2018: 5.

1.3. The Study of Archaeological Footwear

Past studies of archaeological footwear have focused on the production of shoes or using changing shoe styles as a method for dating contexts.[16] In the former, archaeologists seek to understand how shoes were created, what tools were used, and to what materials shoe cobblers had access.[17] In the latter, archaeologists study shoe styles through the centuries to determine the relative dates a particular site was in use.[18]

[16] van Driel-Murray 2001 for stratigraphic dating; van Driel-Murray 2007 and 1993 for construction techniques; Quirk and Beaudoin 2011 for construction techniques of shoes from the historical period in Canada.
[17] van Driel-Murray 2007; 1993.
[18] van Driel-Murray 2001.

Still others have used shoes as a means of estimating foot size and stature of the wearer.[19] The progression of shoe styles worn throughout north-western Europe has been studied so thoroughly that researchers can often date well-preserved shoes recovered from excavations with confidence.[20] Shoe analyses have revealed that the Romans brought knowledge of leather tanning with them to the northern provinces as well as the use of iron hobnails as a robust outer sole layer.[21]

Willy Groenman-van Waateringe's *Shoe Sizes and Paleodemography?* investigates how shoe sizes can reveal demographic information of sites.[22] Her 1978 paper brought together data from six sites, covering the period from the 1st through 15th centuries in Europe, which recorded the range of shoe sizes from each assemblage. The shoes from each site were measured along the sole and the flattened upper to obtain shoe lengths. By using data from the Swift shoe factories in Nijmegen, Netherlands, which provides the range of sizes for women's and men's shoes, she determined that populations on Roman sites were composed of few women and children and many men.[23] This determination came from the percentages of shoes worn by men, women/adolescents, or children found at these sites, based on the measurements obtained. Her study of shoe sizes concludes that there were, in fact, *significantly* more men than women on site. Data from shoes at Vindolanda echo this finding and further

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[19] Groenman-van Waateringe 1978.
[20] Mould 2014.
[21] van Driel-Murray 2007.
[22] Groenman-van Waateringe 1978.
[23] Groenman-van Waateringe 1978. The size as well as the style must play equal roles in the determination of the shoe owner's sex. Styles change through time, and what once was seen as masculine could be seen as feminine later on. When combined with size and style, dating the shoes provides a more certain picture of the sex of the wearer.

research into military site patterns reveals that it is typical to find more men than women and children in military contexts.[24]

A.W. Swallow's 1987 paper on the history of shoes reveals that prior to Romans arriving in Britain, the footwear that the Celtic population favoured was the soft moccasin.[25] This is further explained by van Driel-Murray, who notes that depictions existed (albeit few) of single-piece footwear from the Late Iron Age, none of which remain today.[26] Once the Romans settled in Britain, however, we begin to find remnants of shoes. One such shoe, the *caliga*, was a style popular in the military in the warm Mediterranean environment. It is possible that upon arriving in this damp environment, the Romans realized that this standard military shoe was impractical.[27] The *caliga* has an open-style upper that exposes the toes, laces up the front of the leg with a leather string, and has soles that were heavily studded with iron nails. The open-style shoe would not do much to protect against the wet, colder location of the fort.[28] While Swallow states that many of the hobnails were fashioned into patterned designs on the outer sole, researchers are uncertain of any special meaning given to the pattern. It is here that van Driel-Murray's work proves especially fruitful.

Shoes in the northern provinces have been extensively studied by van Driel-Murray. Her research covers topics such as the craftsmen and consumers of leather shoes, the (missing) leather tanneries in the Roman period, and the social implications of shoe designs.[29] Van Driel-Murray has successfully argued that individual shoes

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[24] van Driel-Murray 1995.
[25] Swallow 1987; van Driel-Murray echoes this in her 2007 publication.
[26] van Driel-Murray 2007.
[27] van Driel-Murray 2007 states that by the end of the first century, *caligae* were being replaced by sturdy boots.
[28] Swallow 1987.
[29] van Driel-Murray 2016; van Driel-Murray 2011; van Driel-Murray 1999.

reveal much information about the wearer. This knowledge is not new, but the reason it stands out is because considerable scholarship on shoes in the classical world has been done predominantly through looking at footwear on sculptures, rather than studying actual footwear.[30] Owing to the environmental conditions of the Mediterranean, many shoes do not survive to this day, and thus cannot be studied fully. The assemblages of shoes that van Driel-Murray studies survived because of the anaerobic conditions in which they were found.[31] Other researchers have made use of the surviving leather objects to conduct their own studies about ancient uses of this organic material.

Quita Mould's expertise also focuses on leatherwork from the past. Most relevant to this thesis is her 2014 publication on homemade shoes from a medieval context.[32] Geographically, her work tends to be situated within Britain, but she publishes on the Roman, Anglo-Saxon, and Medieval periods. Mould notes that archaeological footwear "may represent a rare survival of an under-appreciated traditional craft used from the earliest times in the home to make everyday items for the family that continued in rural communities."[33] Her work is useful because of the idea that shoes were a household craft, which is also what Elizabeth Greene suggests about

[30] Morrow's 1985 book was the first to provide a comprehensive study of Greek footwear through examinations of original Greek statues.
[31] Mould 2014. See also Orr et al. 2021: 15837 in which they describe how the site preserves leather so well: "Between Roman occupation periods, wooden and stone buildings were destroyed, sealed with thick layers of clays and then re-built upon, forming layers in which oxygen was excluded from the decomposing material underneath. This waterlogging above dense clay layers led to the formation of anaerobic layers which are ideal preservation environments."
[32] Mould 2014.
[33] Mould 2014: 306-307. This quote deals with communities from the Middle Ages but remains relevant for the time period considered in this thesis.

the addition of extra hobnails to the outer sole of shoes, a modification that will be discussed in this thesis.[34]

Greene has recently argued that metal shoe attachments demonstrate that Romans had podiatric knowledge.[35] In her paper on the subject, she suggests that shoe modifications may have served as corrective devices for gait issues or to expose the wearer to the healing properties of metals.[36] Greene notes that Pliny the Elder's *Natural History* details the healing properties of metals such as iron, lead, silver, gold, and copper and thus argues that there was common knowledge surrounding the benefits of topically-applied metal.[37] Her work on the leather shoes at Vindolanda has led to the conclusion that at least some in the population understood how to adjust shoes to combat gait issues. This is the first work to suggest that Romans had practical podiatric knowledge.

Francis Grew and Margrethe de Neergaard's research paves the way for understanding the use of footwear for determining foot afflictions.[38] They draw on Swallow's 1975 work to illuminate the health of London's medieval population through wear patterns left on their shoes.[39] Grew and de Neergaard's work provides the necessary information for people unfamiliar with biomechanics to understand the way in which people walk. Their work did not rely on bioarchaeological material to make conclusions about the foot afflictions people faced in the past. Grew and de Neergaard

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[34] Greene 2019: 316. Greene refers to these as 'home remedies', nails that were added post-construction to provide extra support.
[35] Greene 2019.
[36] Greene 2019: 320-321.
[37] Greene includes references for metals in her paper — iron is found in Plin. *HN* (Pliny's Natural History) 34.44-46; lead *HN* 34.50-51; silver *HN* 33.34-45; gold *HN* 33.25, 33.28; copper *HN* 34.23, 33.25-26, 33.28-32.
[38] Grew and de Neergaard 2001.
[39] Swallow 1975 outlines the three areas of footwear that reveal gait: wear marks, especially under the heel; impressions on the insole made by the foot; and creases or bulges in the uppers.

explain the meaning of certain wear marks on the shoes, such as when the inside of the heel is worn down heavily, suggesting the wearer walked with their toes pointed inwards. Another affliction they note is when someone shuffles or walks entirely on their toes, which can be determined through heavy wear on the toe area. Their book combines images of shoes with drawings of the foot conditions that would create the impressions left on the pictured footwear, providing an excellent resource for anyone interested in studying the way that feet and footwear interact with each other.

Jenna Dittmar *et al.* sought to understand the rate of falling that occurred in medieval populations in Cambridge, England.[40] They referenced the pointed-toe style (poulaine) shoes that were popular at that time and argued that people who wore such pointed shoes were more likely to develop Hallux valgus (what we call bunions) than those who did not wear the *poulaine* style.[41] Modern clinical research has shown that people with Hallux valgus experience impaired mobility, struggle to maintain balance, and are at higher risk of falling. Thus, we see that the style of shoes greatly impacts an individual's everyday life. Unlike Grew and de Neergaard, this work privileges bones rather than shoes. Both investigations are useful for answering questions of gait and foot health in the ancient world.

Carolyn White's work on shoes from Boston, Massachusetts in the 18th and 19th centuries introduces the idea that shoes are an intimate artefact that can reveal aspects of the wearer's health, stature, social status, and physicality.[42] Unlike the above examples, White's work is based on an assemblage of shoes dating between the late

[40] Their research sought to understand the relationship between fractures (from falling) and the style of shoes being worn. They noted a higher prevalence of fractures in people who adopted the pointed-style shoes.
[41] Dittmar et al. 2021.
[42] White 2004a; White 2009.

eighteenth to early nineteenth centuries. Like the Vindolanda assemblage that will be discussed in chapters three and four, however, the shoes from White's project came from disposal piles. Because of the public use of disposal spaces, the recovered shoes can neither be associated with a specific class of people, nor a specific time frame. This is comparable to the Vindolanda assemblage, where the fort ditches served as public discard piles. White records that "a person's walk – the cadence of his footsteps, the weight of her footfall, the sound of the material of the sole and heel as it hits the walking surface – is highly individualized."[43] She provides examples of foot conditions that can be determined by a study of the outer sole or uppers, such as bunions, osteoarthritis, and hammer toe, which is a deformity of the second, third, or fourth toe that affects the middle joint. Modifications that White discovered in her case study relate to the cutting of specific parts of the shoe to provide relief from painful rubbing or to accommodate the foot better. Through studying this assemblage of shoes, White provides evidence of post-production modification of shoes, demonstrating the ever-present need for people to walk comfortably in their own shoes.

Since most people in antiquity wore shoes, they are quite revealing of demographic information. The authors above have argued that shoes could be modified post-production to suit the wearer, that modifications could be a home remedy, and that footwear is a rich resource from which to understand the past. Their work demonstrates the wide variety of information that can be learned through a thorough study of such everyday objects as shoes.

[43] White 2009: 150.

1.4. Depictions of Ancient Foot Care

The duty of a podiatrist is to "diagnose and treat the diseases, disabilities, and deformities of the foot by physical therapy, *special shoes* and other mechanical devices, pharmaceuticals, and minor surgery" (my emphasis added).[44] In this thesis, "podiatry" is used broadly to mean practices of foot care that were performed in ancient times. As an established practice of foot care, podiatry can trace its origins back to ancient Egypt and Greece. It is important to note that what has been considered podiatry in the past is not what would be considered podiatry today. Thus, for the purpose of this thesis, the definition of podiatry is aligned with James Skipper and James Hughes, who record the Egyptian roots of foot care and use evidence that Cleopatra employed servants to use ointments and lotions to care for her feet.[45] That Skipper and Hughes write about the use of lotions as a practice of foot care in the past suggests that they view, and define, simple care as a podiatric practice. Since this thesis deals with ancient material, it makes the most sense to use a definition of podiatry that suits the timeframe. As podiatry studies are still quite new in the field of classics, it can be difficult to find a definition that suits the study well, but Skipper and Hughes' will suffice.

One of the largest contributions to information about podiatry in antiquity comes from tombs in Egypt. Though Egypt is geographically distant from the area of focus in this thesis, there are ties between Egyptian and Greek/Roman medicine that cannot be ignored. Hippocrates, whom Galen recognizes as the authority on medicine

[44] Britannica. https://www.britannica.com/science/podiatry.
[45] Skipper and Hughes 1983 delve into a sociological view of the history of podiatry and what the practice of foot care means for us today. They state that while modern podiatry likely began in Europe during the Medieval era, the origins of foot care can be found in ancient Egypt and Greece, where massage as foot care was practiced. Their view of what can be considered podiatry in the past is quite basic, which is particularly well-suited to this thesis. Simple acts of foot care are considered as evidence that these ancient populations understood rudimentary ways to maintain healthy feet.

and massage, traveled to Egypt to study medicine and had access to teachings that were hundreds, if not thousands, of years old during his tenure there.[46] He brought ancient Egyptian knowledge (learned through papyri, people, and potentially images) back with him and used it to inform his own medicinal practice in Athens and beyond. Perhaps one such practice that he learned in Egypt and employed in Greece was the importance of massage as a medical treatment. As it is entirely a possibility that Egyptian knowledge influenced Greek and Roman practice, a brief summary of medicinal massage as practiced by Egyptians, especially how it was applied to the lower limbs, is outlined below.

Researchers like Jean Capart sought to understand the relationship between medical images in the tomb of Ankhmahor (a Sixth Dynasty high-ranking official). Room VI of the tomb features both a circumcision and foot care scene. Capart views these scenes as dioramas of everyday life, recognizing that circumcision was performed by barbers, and massage by the attendants of high-ranking individuals. Capart's work criticized the earlier work of Müller, who viewed massage as a medical practice based on the idea that the entire room showed scenes of surgical care.[47] Capart's work demonstrates the difficulties of determining the meaning of images without additional context.

Engy El-Kilany has undertaken research into foot care scenes coming from Egypt as well. She states that the earliest evidence for foot massage comes from the Fifth Dynasty (approximately 2465-2325 BCE), found in the tomb of Ptah-hotep in

[46] Jouanna 2012 states that the chronological gap between Egyptian papyri and Hippocrates learning medicine in Egypt is not an issue; the papyri extend over a long period from the 1800s BCE until the Ptolemaic period, which was post-Hippocrates, without any major changes in the texts.
[47] Müller 1906.

Saqqara.[48] In the Sixth Dynasty (approximately 2345-2181 BCE), there are two scenes that depict the process of medical massage on the hands and feet. Both Capart and El-Kilany's work have interpreted scenes of foot manipulation to be of medical nature, largely through texts that accompany the images. El-Kilany, using Wahid Omran's work, states that scenes depicting the practitioners handling the tips of fingers and toes in such a way that might cause pain cannot be those that depict pedicure, a beautifying process not meant to produce painful reactions.[49]

In Greece and Rome, votive feet have been recovered from temples. These artefacts demonstrate the desperation and hope of the dedicator, that their ailment may be cured. Ralph Jackson writes about the types of votives that have been found in temples, suggesting that objects in the form of legs and feet are among the most commonly found artefacts.[50]

1.5. Ancient Literature on Foot Problems and Gait

Literature surrounding foot care is found in the writing of ancient medical authors. Theophrastus wrote concerning problems of corns and Celsus noted that they cause pain while walking.[51] Hikesios of Smyrna provides a recipe for a paste meant to treat the same issue.[52] Pliny's *Natural History* mentions the application of fresh wild boar's dung

[48] El-Kilany 2016.
[49] El-Kilany 2016 cites a paper presented by Omran at the Linnaeus University Conference Centre in 2012 titled "Therapeutic Massage and Reflexology in Ancient Egypt (Alternative Treatment)."
[50] Jackson 1988.
[51] Skipper and Hughes 1983 for Theophrastus. Celsus *Med.* (On Medicine) 5 relates the options for treatment when dealing with corns and other foot issues. Popular among the treatments are those that scrape or cut off the offending growth, though applying a paste can also give results.
[52] Skipper and Hughes 1983.

to treat corns, chaps, and calluses.[53] Many of the medical authors focus on the creation and application of multi-ingredient mixtures to heal issues of the feet.

On the topic of gait, Aristotle was the first recorded person to make mention of the way in which people walk.[54] He wrote that "if a man were to walk on the ground alongside a wall [with a reed dipped in ink attached to his head], the line traced [by the reed] would not be straight but zigzag, because it goes lower when he bends and higher when he stands upright and raises himself."[55] His study of gait provides the first interest in understanding the phases of walking and brings the study of feet into a more technical realm.

In antiquity, even satirists wrote about foot problems. Lucian's *Podagra* features a goddess named Gout, her initiates, and the idea that no one is safe from foot pain. In a world where options for health were plentiful, it was all the more disappointing when nothing helped cure the pain. Lucian provides a list of possible remedies that were available for use: incense, sacrificial offerings and votives, medicinal concoctions, minerals, sacred incantations, spells, and animal body parts with human waste.[56] Despite the variety of pain management options available, none seem to have effectively removed or even minimized the suffering that was endured. A careful study of the text conducted by Georgia Petridou led to her conclusion that "morbid laughter...the *risus purus*, that is the body's automatic audible response to the absurdity of pain and physical agony, is recommended in the play as the only effective coping mechanism against the suffering caused by the disease."[57] Studied through a

[53] Plin. *HN* 28.
[54] Baker 2007.
[55] Arist. *IA* (Aristotle, *Progression of Animals*) 709a. From the LOEB Classical Library, translated by A.L. Peck and E.S. Forster.
[56] Luc. *Trag*, (Lucian, *Podagra*) lines 140-173.
[57] Petridou 2018: 488.

modern lens, *Podagra* delivers a message that continues to be relevant today: laughter is the best medicine.[58] That a satirical play was written centering on gout demonstrates how prevalent a concern gout was for society.

Unfortunately, the texts pertaining to non-herbal medicinal practices of foot care are sparse in the classical world. Most of the medical texts focus on the treatment of corns or relieving pain, typically focusing on the creation of pastes meant for topical application. Missing from the texts are ways in which to manage painful walking conditions through non-medicinal means, though many citizens must have been afflicted with them. Archaeology, therefore, is a crucial complement to the written sources, since it reveals the everyday reality of those who lived in the past. Since remedies could be passed down through word of mouth, rather than being written down, archaeological investigation allows us to consider what knowledge was possessed in antiquity. It is also important to remember that a lack of written sources does not signify a lack of knowledge held.

[58] Petridou's 2018 paper on Lucian's Podagra concludes that the laughter that the body naturally produces is the only effective treatment for gout.

Chapter 2:

Foot Care in Antiquity

2. Introduction

Medical anthropologists have shown there are multiple structures of care in societies, rather than one strict medical system.[59] Individuals may resort to one system or another, based on economic concerns, access to physicians, illness, and previous experiences. In Greece and Rome, options for healthcare could include healing cults, herbal remedies, seeing physicians, charms, incantations, amulets, and spells. Baker writes that "it is clear in the epigraphic and archaeological evidence that some Roman doctors were practicing practical medicine…the basic technical areas of medicine such as bandaging or surgery, alongside practices with more religious overtones, as some altars were dedicated by doctors asking for the help of healing deities."[60] This chapter considers questions pertaining to what exists in the medical authors' corpus' dealing with foot issues and what the standard of care was in the Roman army. In chapter four, a globalized approach to foot care is undertaken, with the aim to understand the importance of massage as a means of treatment.

2.1. Foot Conditions and Herbal Remedies

In Classical antiquity, physicians were aware of conditions affecting the feet. Common conditions of the lower extremities included fallen arches, in-grown toenails, torn ligaments, wounds and ulcerations, deformities such as a clubbed foot, sprains,

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[59] Oberhelman 2014.
[60] Baker 2000: 27.

dislocations, or most often, arthritic joints.[61] Celsus seems to have used the term *podagra* to describe any pain in the feet.[62] Jackson suggests that the pain Celsus refers to is gout, which is a form of arthritis typically affecting the first metatarsophalangeal joint of the big toe. Gout tends to affect the joint of the big toe first, then gradually moves throughout the rest of the feet and hands.[63] Gout is caused by a build-up of uric acid (a naturally occurring acid in the body) that generally affects men more than women. Though naturally occurring in the body, consuming red meat and wine raises the level of uric acid in the body, so anyone with a diet richer in those substances may be affected more. Those suffering from gout would experience swelling in their joints, inflammation, pain, and often restricted movement of the joints.[64] To treat this affliction, Pliny recommends a mixture of wool-grease (*oesypum*), woman's milk, and white lead, or sheep dung, or mice split and laid on the affected area.[65] He also mentions how salt, burnt with a viper and placed in a jar, and taken freely relieves gout, especially with the addition of viper fat rubbed into the feet.[66] Rubbing the feet with the blood of a kite may also relieve pain, as well as the blood of a pigeon if it is combined with nettles.[67]

Someone suffering from achy feet could be prescribed rubs and plasters to remedy their condition. Amarantos the Grammarian (1st C BCE) supplies a sore foot remedy that uses 32 ingredients, including analgesics (frankincense), astringents (gentian), anti-inflammatories (butcher's broom, St. John's wort), and warm botanicals

61 Irby-Massie 2009; Jackson 1988.
62 Jackson 1988.
63 Gritzalis, Karamanou, and Androutsos 2011.
64 Jackson 1988.
65 Plin. *HN* 30.23.
66 Plin. *HN* 30.23.
67 Plin. *HN* 30.23.

(yellow iris, cardamom, eryngo, ginger).[68] Galen's *About Remedies* mentions a 21-ingredient emollient attributed to Andreas (3rd C BCE) that helps to relieve all kinds of pain, including aching joints and painful feet.[69] For cracked and callused skin on the feet, Dioscurides (1st C CE) suggests using raw pitch, chaste tree, or common polypody ("many-footed"), a fern whose name may be related to its use for many foot conditions.[70] Another option to treat sore feet was to ingest snails, specifically "the broad, flat, kind of snail."[71] The crushed snail was, apparently, an analgesic substance. To remove corns on the feet, Pliny writes that "the urine of a mule of either sex is applied, mixed with the mud which it has formed upon the ground; sheep's dung, also; the liver of a green lizard, or the blood of that animal, applied in wool; earth-worms, mixed with oil; the head of a spotted lizard, pounded with an equal quantity of vitex and mixed with oil; or pigeon's dung, boiled with vinegar."[72]

2.2. Non-Herbal Treatments for Common Foot Ailments

Hippocrates' work *In the Surgery* offers insight into the use of massage as a treatment for gait correction. He writes that dislocations, sprains, avulsions, and fractures near joints can be corrected by bracing the side towards which the deviation occurs and using a combination of bandages, compresses, suspension, friction (what can be called 'massage') and adjustment.[73] According to Hippocrates, the unwell limb ought to be bandaged well, not overly compressed, and massage should be employed to stimulate

68 In Irby-Massie 2009.
69 Galen, *About Remedies* 2.17.
70 In Irby-Massie 2009.
71 Plin. *HN* 23.9.
72 Plin. *HN* 23.9.
73 Hippoc. *Off.* (Hippocrates, *In the Surgery)* 23.

the affected area. If used properly, not only does massage provide a stimulating experience for the patient, but it has the ability, too, to correct the improper placement of joints.

In *About Fractures,* Hippocrates provides a treatment plan for someone with a clubbed foot. He describes the treatment thus: "moulding, resonated cerate, plenty of bandages, *a sandal* or sheet of lead bound in with the bandaging, not directly on the flesh; let the slinging up and attitude of the foot be in accordance."[74] Despite it not being the central focus of the treatment plan, this is one rare instance where footwear is recorded in the process of correcting foot issues. Throughout *About Fractures,* Hippocrates also writes of dislocations and of legs that are unequal length. To aid with these difficulties, he suggests the use of a crutch so that the lame foot does not need to be fully utilized.[75] In chapters three and four of this thesis, a metal plate modification will be discussed which could be used if someone dragged their foot along.

If preventative measures were not successful for warding off foot pain, those afflicted could petition the gods for relief. Jackson's work found that legs and feet were commonly used ex-votos that were dedicated by those either supplicating or giving thanks for a cure to one of many disorders that affect the lower limbs. Votive offerings reveal the strong desire, or more likely, the desperation of the dedicatee to reclaim their health. Interestingly, although practices of dedicating votives had almost died out in Italy by the first century BCE, the practice remained for several more centuries throughout Gaul and Britain.[76] This perhaps demonstrates that changing attitudes towards the use of votives began in Italy but took a different trajectory in the provinces.

[74] Hippoc. *Art.* (About Fractures) 32. Translated by E.T. Withington, 1928.
[75] Hippoc. *Art. 23.*
[76] Jackson 1988.

Regardless of the spread of votive use throughout the empire, there is plenty of evidence to suggest that people earnestly sought relief from their ailments by petitioning the gods. Whether a first attempt at being cured, a desperate last effort, or used in conjunction with other treatments, votive dedication was an important part of the healing process.

Thousands of votive offerings have been found in a variety of temples. At Ponte di Nona, a temple dedicated to an unknown deity was found to have over 8,400 body parts.[77] Of these, nearly 6,000 were clay figures of hands and feet, and arms and legs. Ponte di Nona was a rural sanctuary that would have serviced a large agrarian population: the city contained farmers, labourers, and peasants, all of whom could be susceptible to injuries like cuts, contusions, twisted limbs, and dislocated joints while working in the fields. It is, therefore, unsurprising that this population brought forth so many votive offerings in hopes that they would have a full recovery. There is even evidence for votive offerings being used in a Romano-British context. A small votive offering shaped like a forearm was found at the healing temple at Lydney Park in Gloucestershire.[78]

Recent work by Tomáš Glomb has proven that the spread of the cult of Asclepius across the empire was related to the spread of soldiers.[79] From Britannia down to Africa, the cult of Asclepius was established in close proximity to the legionary forces. He writes that "it is possible that across the provinces of interest (Britannia to Moesia Inferior) the military positions had each of the cults (Asclepius, Apollo, Minerva, Jupiter) significantly closer than was the case for settlements."[80] In essence,

[77] Potter and Wells 1985 but see Griffith 2013 and Oberhelman 2014 for additional context.
[78] Summerton 2021.
[79] Glomb 2021.
[80] Glomb 2021: 13.

while healing cults were used by many people, those that most relied on them were soldiers. Since soldiers faced battles and often returned wounded, healing cults would have provided them with comfort and the thought that they could be healed. Asclepius was popular not only because he was a healer, but largely because he was perceived by worshippers to take a direct interest in their lives.[81]

2.3. Health Care in the Roman Army

In 1856, Sir James Simpson first asked if the Roman army was provided with medical officers.[82] Since then, much time has been dedicated to gaining a fuller picture of healthcare in the Roman army. The study of healthcare in Roman Britain has been summarized by Allason-Jones, who concludes that the evidence for healthcare is "very uneven."[83] There is archaeological evidence in the form of basic medical instruments, some epigraphic evidence, and bioarchaeological analysis, all of which leaves many gaps to fill. Practices pertaining to diagnosis and treatment reveal the scope of knowledge that a society possessed and whether they were learning from others around them. Patricia Baker notes that "various beliefs could have been introduced to, or at least been familiar to, military doctors" and that "it is possible that some doctors could have adopted or adapted the medical practices they might have learned by being stationed in different regions of the empire."[84] Before becoming a part of the Roman army, there were certain checks the hopeful-soldier must pass. According to Vegetius,

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[81] Renberg 2007.
[82] Simpson 1856.
[83] Allason-Jones 1999: 144.
[84] Baker 2000: 68.

the recruiting officer ought to conduct a physical examination, and observe the musculature of a person to choose an able soldier. The chosen person ought to have:

> alert eyes, a straight neck, broad chest, muscular shoulders, strong arms, long fingers, small stomach, slender buttock and calves and feet that are not swollen by surplus fat, but firm with hard muscle.
>
> *vigilantibus oculis, erecta cervice, lato pectore, umeris muscolosis, ualentibus brachiis, digitis longoribus, ventre modicus, exilior clunibus, suris et pedicus non superflua carne distentis sed nervorum duritia collectis.*[85]

An ink tablet excavated at Vindolanda records some of the common ailments affecting soldiers listed in three categories: sick (*aegri*), wounded (*uulnerati*), and eye problems (*lippientes*).[86] Soldiers listed with these conditions were recorded as unfit for duty. If soldiers required long-term care, they could be transferred back home or sent to a coastal area to heal. It appears that military hospitals were not equipped to handle long-term patients.[87] Some curse tablets found at Bath in Britain suggest that military personnel did, in fact, seek out the town for its curative springs.[88]

It was important that soldiers were physically fit individuals, and this attitude carried into the belief that exercise in armour was better for a soldier's health than a visit to the doctor.[89] Thus, infantry and cavalry were advised to train daily, even during inclement weather. Soldiers were advised to fell trees, carry heavy objects, jump ditches, swim, march at full step, and even run in their armour with their packs.[90] All

[85] Veg. *Mil.* (Vegetius, *About the Military*)1:6; Translated by Milner, 1996.
[86] Bowman and Thomas 1991.
[87] Allason-Jones 1999; Jackson 1988.
[88] Allason-Jones 1999.
[89] Baker 2000.
[90] Veg. *Mil.* 1.9; 1.10; 1.19.

this physical activity not only kept soldiers busy, but acted as preventative care. Yet another way that the army sought to protect soldiers was by discharging those whose suffering prevented them from remaining and furthering their military career. Baker argues that the fact that doctors were able to discharge soldiers because of ill health "is a demonstration that precautions were taken in the army to keep the seriously ill or wounded from becoming a burden to the army, and it would allow for soldiers to recover properly."[91]

Perhaps another precaution taken by the Roman army was to ensure their soldiers had shoes that were made especially for them. A rather interesting quote from Galen's corpus introduces the idea that military personnel may have had access to shoes made especially for them. He records:

> Nevertheless, in truth, the art of gymnastic training is different, just as that of archery is; the art of wrestling throws is like that of generalship, while that of gymnastic training is like the medical art; each of these serves two arts set above them. In this way too, the shoemaker is taught by the general on the matter of a useful shoe for a certain soldier, while he is directed to make one that is suitable for health by the art concerning the body.
>
> καίτοι κατά γε τὴν ἀλήθειαν ἕτερον μέν ἐστι παιδοτριβικὴ καθάπερ ἡ τοξευτική, καταβλητικὴ δ'οἷόνπερ ἡ στρατηγική, γυμναστικὴ δ' οἷον ἡ ἰατρική, καὶ διτταῖς ὑπηρετεῖ τέχναις ἐφεστώσαις ἑκάστη τῶν τοιούτων. οὕτω γὰρ καὶ ἡ σκυτοτομικὴ τὸ μὲν ὡς στρατιώτῃ τῷδέ τινι χρηστὸν ὑπόδημα παρὰ τῆς στρατηγικῆς ἐκδιδάσκεται, τὸ δ' ὡς εἰς ὑγίειαν ἐπιτήδειον ὑπὸ τῆς περὶ τὸ σῶμα τέχνης ἐργάζεσθαι κελεύεται. [92]

[91] Baker 2000: 97.
[92] Gal. *De san. tuenda* (Galen, *Hygiene*). 893K. Translated by Ian Johnston, 2018.

This quote reveals that, ideally, the shoemaker would construct shoes with the wearer's occupation and personal needs in mind. Those in the military, accustomed to long marches, needed shoes that would not wear down quickly. Such soldiers were on their feet for many hours each day, and therefore needed shoes that would provide sufficient support. Especially in the hilly regions of England, where Vindolanda is located, shoes needed to support the ankle to make sure that they would not roll because of the terrain. Proper footwear should be considered a part of health care, a preventative measure that would inhibit sprains and aches.

2.4. Conclusion

This chapter has provided a brief overview of medical practices in the past for foot care. A survey of the medical writings shows that many herbal remedies were recommended to combat pain and issues such as corns on the feet. The medical authors' writings do not detail any use of shoe modification for correcting walking conditions that could cause pain over time.[93] If such modifications were a form of treatment one took upon themselves to perform, then it is quite possible that the information was passed down orally from person to person.

The Greek and Roman medical authors' writings and evidence of votives demonstrate that foot care was important in the past. There were numerous methods that a person could use to treat lower limb issues. While mixing ingredients to create topically-applied pastes was one of the most common methods of treatment for painful feet, this chapter demonstrates that there were also other avenues of treatment available.

[93] With the exception of Hippocrates' treatment of clubbed foot.

In the final two chapters of this thesis shoe modifications are added to the list of ways that one could treat lower limb issues. In the final chapter, foot care practices from other ancient societies will be discussed. By globalizing foot care in the past, we can gain a broader understanding of the possible knowledge that existed concerning the care of feet.

CHAPTER 3:
Vindolanda and its Shoe Assemblage

3. Introduction

This chapter contextualizes the site of Vindolanda, showing its location and providing a discussion of its archaeological importance, followed by a description of the assemblage of archaeological shoes and leather. A brief explanation of the typical construction of shoes is provided so that the modifications to the affected shoes may be better appreciated. Understanding the standard construction of shoes allows for a determination of the types of modifications applied during or after production. By studying a selection comprising over 400 shoes, five categories of modification were found: metal orthotics, bronze disks on the insole, hobnails placed on the insole of the shoe, additional pieces of leather between sole layers, and supplementary hobnails in the outer sole. Some of this evidence has previously been examined and discussed in terms of the podiatric knowledge that the Roman military possessed.[94] This case study, therefore, seeks to extend that discussion to include more examples that have been found in the assemblage since the initial work on the shoes. This case study also considers broader lines of inquiry that the modifications reveal, a topic that will be covered in chapter four.

[94] Greene 2019.

3.1. Vindolanda and its Shoe Assemblage

Vindolanda is a Roman auxiliary fort located centrally in the Hadrian's Wall corridor and was part of the original frontier line in this region, now called the Stanegate System, dating to the late 1st century CE (fig. 3.1).[95] Vindolanda had nine continuous phases of occupation from 85 CE to well into the post-Roman period.[96] The Roman army was first housed at Vindolanda around 85 CE, after the Roman general Agricola consolidated the northern frontier. The site is located just 3km south of Hadrian's Wall, which was the defensive barrier constructed in the 120s CE to mark the northern frontier of the Roman empire. Emperor Hadrian ordered the construction of this wall to consolidate the frontier and enforce control of the region.[97] The wall extended for 118km (73 miles) from Wallsend (Segedunum) on the River Tyne in the east to Bowness on the Solway Firth in the west.[98] Hadrian's Wall was built primarily by soldiers of the three legions stationed in Britain (II Augusta, VI Victrix, XX Valeria Victrix), but it was garrisoned by the second-line auxiliary troops that were raised from the conquered provinces of the empire.[99] Through its many occupations, Vindolanda housed cohorts of Tungrians, Batavians, Nervians, and Gauls. These auxiliary troops originally came from modern day Belgium, Netherlands, northern France, and central France, respectively.[100]

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95 Hodgson 2000.
96 A. Birley 2003; R. Birley 2009.
97 Breeze 2019. Theories have recently been put forward suggesting other reasons for the construction of Hadrian's wall. A thesis by Mylinh Pham 2014 categorizes the main theories thus: defensive theory, economic theory, and symbolism theory.
98 Breeze 2022.
99 Allason-Jones 1999.
100 http://vindolanda.csad.ox.ac.uk/exhibition/people-1.shtml. Roman auxiliary units were non-citizen units raised in the conquered provinces of the empire. For full treatment of the auxiliary units and recruitment, see Haynes 2013.

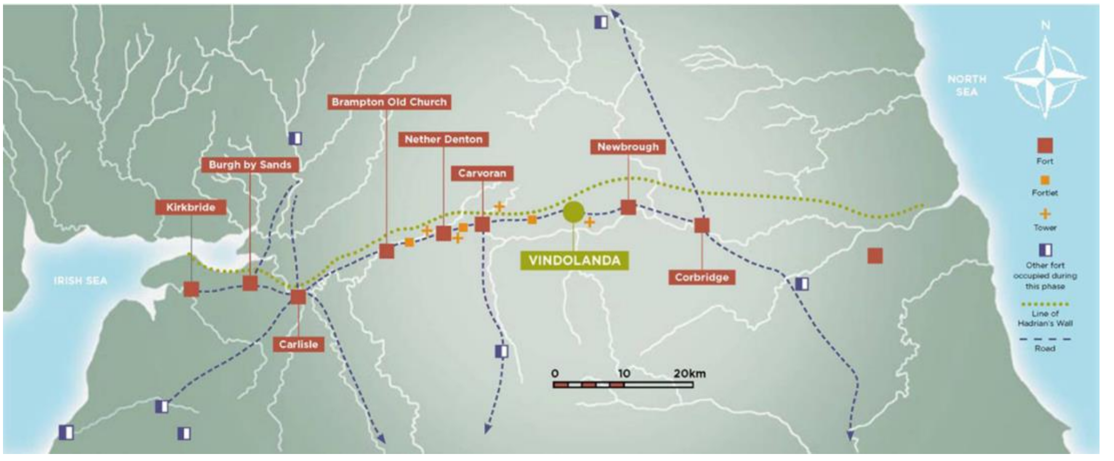

Figure 3.1: Location of Vindolanda along the Stanegate Road and Hadrian's Wall. Image copyright of The Vindolanda Trust.

Period of Occupation	**Dates**	**Garrison**
1	c. AD 85-90	I Tungrorum
2	AD 90-100	I Tungrorum, IX Batavorum
3	AD 100-105	IX Batavorum
4	AD 105-118	I Tungrorum, Vardulli cavalry
5	AD 120-130	I Tungrorum
6	c. AD 140-160	II Nerviorum
6A	c. AD 160-200	Unknown
6B	c. AD 200-212	Unknown
7	c. AD 213-275	IV Gallorum
8	c. AD 300-367	IV Gallorum
8A	c. AD 367-408	Unknown
9A	c. AD 409-600	Brigomaglos Warband
9B	c. AD 600-800	Population Unknown
10	AD 800+	Population Unknown

Table 3.1: Periods of occupation, the corresponding dates, and the garrisons that were stationed at Vindolanda during each occupation.

The population at Vindolanda was comprised of a military auxiliary unit and its surrounding community, which included veterans, women, children, merchants, and more.[101] Thus, the shoes that are examined in this chapter could have belonged to soldiers or civilians, including men, women, and children. Shoes from various occupation phases are used as evidence to investigate intentional shoe modifications. The assemblage of leather shoes and other leather products is preserved largely because many of the archaeological contexts at Vindolanda are preserved in anaerobic environments, which prevent bacterial breakdown of the material. Aside from the incredible preservation of leather remains, the earliest Roman forts at Vindolanda were constructed with timber, resulting in the preservation of individual buildings and spaces in which leather remains are found.[102] Vindolanda is unique in the empire because of its excellent preservation, owing to the environmental conditions in which the site is located. In addition, the Roman practice of vegetable tanning created water-resistant leather that is more robust than Iron Age leather.[103] The combination of vegetable tanned leather with anaerobic deposition means that the shoes have been preserved in excellent condition. The state of the shoes at deposition plays a role in their survival, as do the taphonomic conditions they endured since they entered the archaeological record. Prior to Roman occupation in Britain, leather products in this geographical zone are rarely preserved because they lack permanent water resistance that the tanning process provides.

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[101] R. Birley 2000; Greene 2013a, 2013b, 2014 focus specifically on the community present at Vindolanda in the period just after conquest and settlement of the region.

[102] R. Birley 2009, 1994.

[103] van Driel-Murray 2001. Orr *et al* (2021) explain that multiple phases of occupation, each sealed with thick layers of clay and then built upon again, produced layers of oxygen-deprived material. Waterlogged layers above the sealed areas created anaerobic conditions, which are ideal for preservation. Taylor et al. 2019 confirm that these conditions are ideal to preserve organic material.

Vindolanda contains over 7,000 leather objects, ranging from shoes (over 4,000, in various states of preservation conditions), to tent panels, military equipment, horse saddles, straps, toggles, and children's toys.[104] These everyday objects reveal demographic information of the site, such as the fact that children were a part of the military community from the start of occupation on the site. The shoes, for their part, reveal interesting information about the health of their wearers. To understand how they were altered for their owners' comfort, we first must understand how they were typically constructed. Roman shoes were constructed in very specific ways throughout the empire, so any shoe modification, outside of changing styles throughout the years, stands out.

3.2. Roman Shoe Construction

Roman shoes were complex constructions, which means that they were created with several different components: an insole, outer sole, multiple midsole layers, a heel stiffener, and uppers.[105] Shoes were created from an assortment of leather types — thick cowhide for the soles, and softer or thinner leathers for the uppers and shoe linings. Van Driel-Murray hypothesizes that high-end shoes may have also utilized deerskin or other luxury fabrics.[106] In archaeological terms, there are six groupings of shoes: *carbatinae*, which were made from a single piece of leather without hobnails on the outer walking sole; *caligae*, which were military boots; *calceii*, closed shoes; *socci*, slippers; *soleae*,

[104] Vindolanda Archaeological Leather Project https://www.vindolandaarchleather.com/about.
[105] Quick and Beaudoin 2011.
[106] van Driel-Murray 2007.

sandals; and *sculponeae*, shoes with wooden soles.[107] All these shoe types were equipped with a sturdy outer sole of iron hobnails, either set in a pattern or set in straight lines for maximum coverage, except for the *carbatinae*, which lacked metal studs or any durable walking surface. The longevity of the shoe depended on its construction, its purpose, and what manufacturing techniques were used. Due to the nature of the shoes involved in this case study, the complex, hobnailed shoes remain the primary focus. These are the shoes which offer the best opportunity to understand shoe modifications and gait correction.

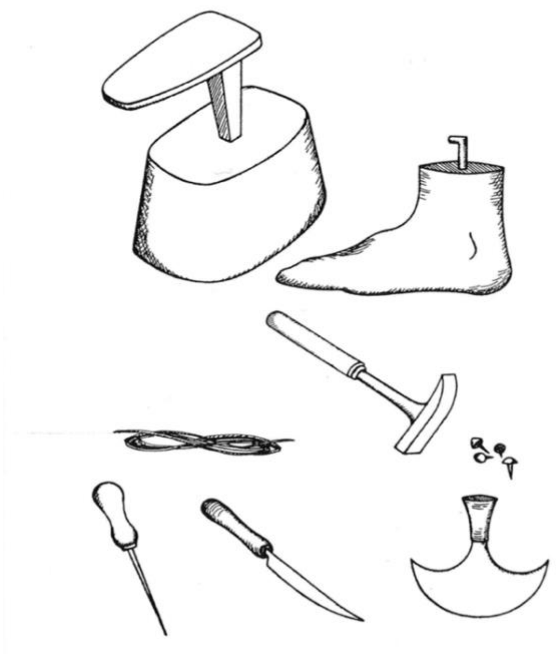

Figure 3.2: Roman shoe-making tools. From van Driel-Murray's chapter in *Stepping Through Time,* 2007: 339.

[107] van Driel-Murray 2007: 345-346. The six groupings of shoes are a modern invention based on the words found in textual sources used to help archaeologists study footwear. The Romans had an extensive collection of terms for different types of shoes that we cannot fully understand today. As a result, the six groups are based on the technology used and, to an extent, the purpose the shoe served. Van Driel-Murray notes that the Roman terms could have potentially related to technology used, style, type of leather, colour, or even the occupation of the wearer.

Most Roman shoes were constructed with multiple layers of soles, which were attached to the uppers via stitching.[108] Uppers, as their name suggests, are the top part of the shoe. Soles were created from cowhide measuring between 3-5mm thick that had been compressed through either hammering or rolling.[109] The entire shoe, comprising multiple layers, was nailed, thonged, or sewn together from the outer sole through to the upper.[110] A shoe with nailed construction has an upper attached directly to the shoe sole by nails. Thonged shoes are those which attach the midsole layers to the insole by means of narrow pieces of leather rawhide. Even if the leather thongs do not survive to the present day, slits where the thongs were placed remain visible on the insole. Leather shoes were created much the same way throughout the centuries, with Medieval era shoes copying many of the same designs as earlier Roman shoes. Tools that are similar in both periods are knives, awls, wooden lasts, and the addition of hobnails required various sizes of nails, anvils, and a hammer (fig. 3.2).[111]

Though leather shoe construction remained mostly stable throughout the centuries, Romans differed from other European societies in that they used hobnails on their outer soles. While these hobnails were structural in purpose, they also functioned as a decorative element. There are many examples of shoes in the archaeological record that have stylized hobnailed soles, whereas others are spaced evenly along the area of

[108] According to Janisse 2008 shoes with midsoles are the easiest to modify. The midsole layers add a solid platform and make for a most sturdy shoe construction.
[109] During my investigation of the shoes at Vindolanda one shoe (labelled L-1994-4242) was observed with quite thick sole layers. Dr. Greene, who extensively studies the Vindolanda assemblage, was surprised at the thickness of the soles and suggested that they could be for a person who had issues walking. This sole also has a bronze disk on the insole and will be discussed in the case study below.
[110] van Driel-Murray 2007.
[111] van Driel-Murray 2007.

the outer sole.[112] Hobnailed shoes also lasted longer than those without the extra layer between leather sole and rough ground, which made them quite desirable. Roman soldiers were allotted three pairs of shoes per year, so they needed to make sure that theirs remained intact until their next allotment of footwear.[113]

Much like Roman *caligae,* Greek *κρηπῖδες* (krepides) were shoes designed to last on long marches.[114] These shoes were built with thick soles and bound with numerous straps. Both shoes featured hobnailed outer soles, which helped to slow down the wear on the soles. Shoemakers placed hobnails skillfully so that soldiers were able to endure long distances without their shoes wearing down. Thick soles provided as much comfort as possible while spending long hours on difficult terrain. Shoemakers were aware of the needs of their clients, creating shoes that were designed with specific purposes in mind. The following section details the modifications that shoemakers, or the owners themselves, performed on shoes to help alleviate common foot conditions that the community at Vindolanda experienced.

Archaeologists have borrowed technical terms from shoemakers in order to label excavated footwear. Figure 3.3 provides labels that will be useful to the reader during the Vindolanda case studies presented below. Important terms are those that relate to areas of the sole: toe, tread, waist, and seat. These terms simply refer to specific zones on the sole where the foot comes in contact. From toe to heel, the terms thus refer: the toe is where the toes rest; the tread area is the junction where the toes meet the rest of the foot; the waist is the narrowest area between the toes and the heel; and the seat is where the heel of the foot is located.

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[112] See van Driel-Murray 2007, especially pages 351-52 for examples of decorative tread soles.
[113] van Driel-Murray 2007.
[114] Morrow 1985.

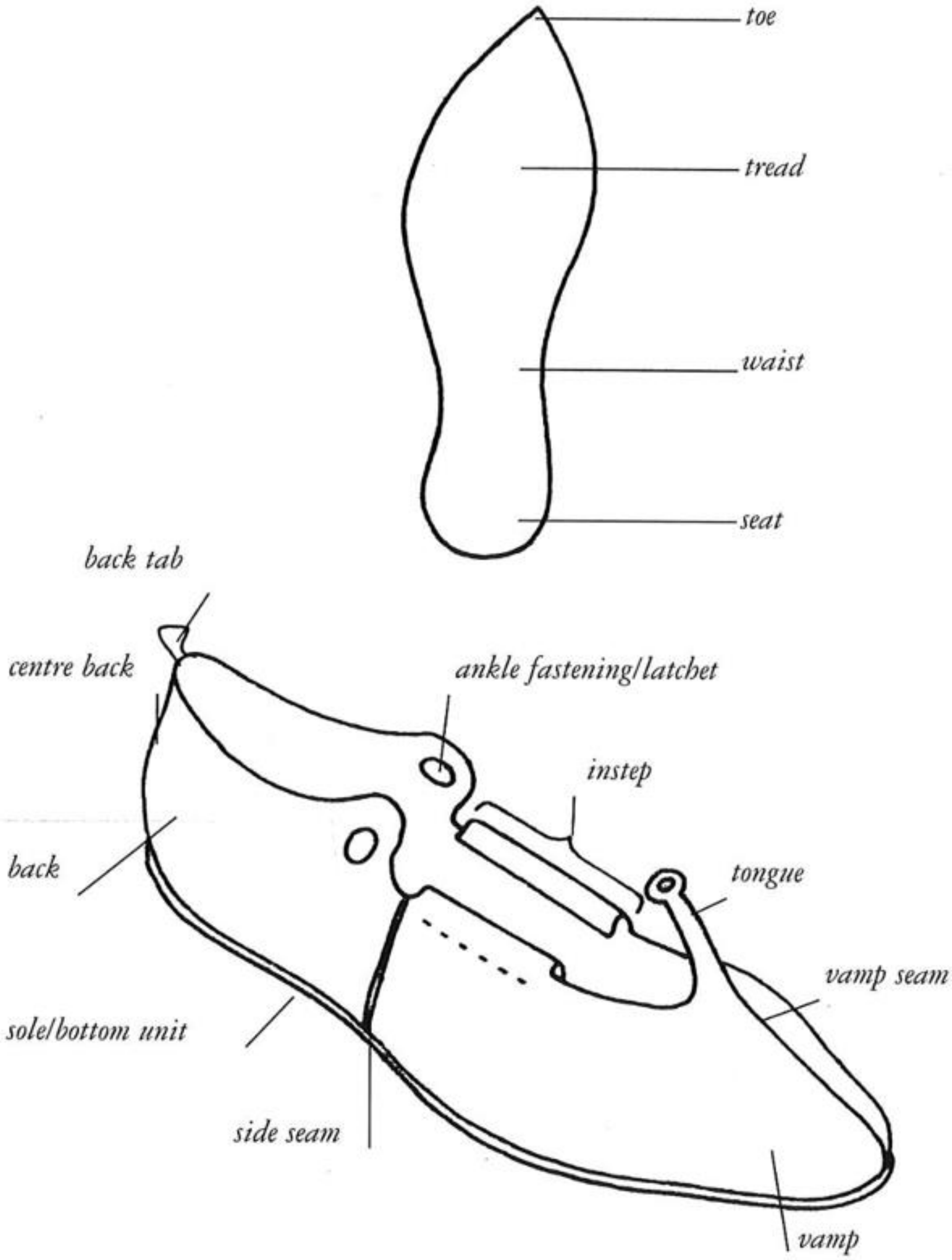

Figure 3.3: Parts of a shoe. From van Driel-Murray 2007: 345.

3.3. Vindolanda Footwear Case Study

Many of the shoes in this thesis have previously been the subject of interest by Greene and van Driel-Murray.[115] Though the shoe assemblage has already been the subject of numerous papers, books, and presentations, only a recent publication by Greene has undertaken the subject of shoe modification at Vindolanda.[116] Foot care is still a novel avenue of research in Roman studies, and thus this thesis is well-situated to aid this new venture. The Vindolanda assemblage consists of over 5,000 shoes and shoe scraps, which is the largest number of archaeological shoes anywhere in the Roman world.[117] For the present case study, 434 of these shoes were studied for modifications. The shoes in this study cover a span of multiple occupation periods, which demonstrates the long tradition of modifying shoes to better serve those that own them. The modified shoes range from occupation Periods 1 to 7, spanning approximately 200 years of settlement at Vindolanda (ca. 85 to 275 CE).[118] Appendix A contains images and data of every shoe mentioned in the case study. In this chapter, I have selected one or two images per category of modification that best demonstrate the feature. Circled in red are the areas in which the modifications are located on the shoes.

[115] See for example van Driel-Murray 2001; 1995; 1993; Greene 2019; 2014a.
[116] Greene 2019 for shoe modifications. For the most recent treatments of the Vindolanda shoes, see Greene 2014, 2018; Greene and Birley 2020.
[117] 3,340 shoes were excavated and determined to be in good enough condition to warrant studying. The remaining number are shoe scraps, or were unassignable to a sexed owner. Since only 3,340 shoes are in decent condition and can be tentatively assigned an owner, that is the number used in the following paragraphs.
[118] Periods 1 through 7 span the years 85 – 275 CE. In personal correspondence, E. M. Greene suggested that L-2005-67A, the Period 7 shoe, appears to have been discarded closer to the beginning of the phase of occupation (213 – 275 CE), and could have even been from Period 6B. Buried artefacts can move between stratigraphic layers because of disturbances to the contexts in which they are situated. Thus, the shoes in this study could, in reality, cover a shorter time span than indicated above.

3.4. Method

The excavations at Vindolanda from 1985 until 2017 have produced 3,340 shoes that are complete enough to provide useful data for this investigation. This entire assemblage was used to investigate certain types of modifications, such as added metal bars on the outer sole of shoes and studs and discs on the insole, from which 11 shoes were found to have been significantly modified. Because the assemblage is so large, however, it was not possible to investigate every shoe for other types of modifications that are less visible in images and illustrations, such as added studs on the outer sole. It was determined that footwear from the 2016-2017 Severan ditch excavations would be investigated for less visible shoe modifications,. Thus, 380 shoes from the 2016 excavation and 43 shoes from the 2017 excavation in the Severan-period fort ditch were studied for alterations, for a total of 423 individual shoes investigated from this period. Since only the Severan ditch shoes were investigated for supplementary hobnails and additional padding, the number of shoes with each of these two modification types are incomparable with the other three modification types (metal bar orthotics, bronze studs on insole, and iron studs on insole). Whereas the former modifications were only looked at from the 2016-2017 investigations, the latter three modifications were observed from the entire assemblage of shoes from 1985-2017.

Though we already know that there are shoes with supplementary hobnails found throughout multiple periods of occupation, and while we are almost certain other shoes exist which have additional padding, the time constraints of a thesis project prevent the opportunity to study every single shoe from the Vindolanda assemblage. Therefore, the Severan ditch shoes were chosen because they provide a sample of shoes from a variety of different community members living on site at the same time. Since the defensive ditch acted as a refuse pit for the inhabitants of Vindolanda and its community, the shoes found in it offer a selection of footwear in all states of disrepair, owned by soldiers and non-combatants. This ditch was part of the defensive systems at Vindolanda which sought to dissuade or at least slow down invaders. At the conclusion of a unit's time on site, they would seek to fill in the defensive ditches, not wanting to leave behind a well-defended space for others to take, and they discarded any items that were unnecessary as they moved to the next garrison. Therefore, the shoes found in the ditch represent not only shoes from the whole military community, including women and children, but also shoes that had various states of wear. Some shoes in the ditch were entirely worn through, while others had minor wear, but for whatever reason would not be packed for the next leg of the journey. Considering that an examination of every shoe could not be undertaken, it was determined that a sample containing shoes from the broader community in a single phase of occupation would present the best chance of revealing the modifications that were undertaken at Vindolanda.

Following methodology set out by Grew and de Neergaard's work on Medieval era shoes, each shoe was visually and physically inspected prior to photographing, seeking out obvious irregularities.[119] Shoes were examined and photographed on a white photo board next to a forensic-issue scale. Most shoes were handled while wearing disposable gloves, as the naturally occurring oils on skin would otherwise transfer to the leather soles.[120] The details of each shoe and any perceived irregularities

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[119] Swallow 1975 was the first to recognize what information could be learned from a close study of shoes. Grew and de Neergaard 2001 took this information from Swallow's study and applied it to a population from medieval London. Their work shows how archaeological footwear may be studied in a real population (as opposed to Swallow's work which does not use shoes from a specific site).
[120] The issue of wearing disposable gloves when handling certain artefacts is debated. Some gloves may leave behind fibers if used while handling an object, which may be more harmful than allowing naturally occurring oils in the hands to interact with artefacts. One argument for handling vellum or leather objects

were recorded in an Excel sheet with notes detailing the specific modifications. Among the shoes used in the study, the most obvious modifications included metal bars attached to the tread sole and iron studs and bronze disks placed on the insole. Less obvious modifications included extra pieces of leather placed between the sole layers and additional studs hammered in different locations of the outer sole, which appear to be concentrated in areas of the foot that needed further support.[121] The additional studs were identifiable because they disrupted the overall pattern of nailing that the original shoemaker had put in place. Though not every shoe studied was created with a discernable hobnail pattern, enough were that the patterning or spacing of the hobnails allowed for a determination of hobnails that were added secondarily.[122]

The method of examination relies wholly on noticing differences between common construction and additional work on the shoes. Using certain light-scanning technologies, shoe soles could be studied to gain even more information about gait wear and where people placed most pressure when stepping. Imaging technologies can also be used to discern the actual size of a foot, instead of relying on an estimation based on the soles. The use of 3D imaging to obtain more specific information about gait and foot size is beyond the scope of this chapter and will not be dealt with in this thesis.[123]

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with bare hands is that the oils help to keep these materials supple, which can be useful so they do not become too stiff and break in later years. The National Park Service has created a helpful reference guide for what types of gloves to use and when they are the appropriate choice when handling artefacts. The guide can be found at https://www.nps.gov/museum/publications/conserveogram/01-12.pdf.

[121] Greene 2019.

[122] van Driel-Murray (2007: 350) notes that hobnails were not only structural in purpose, but also became a type of fashion accessory in some places throughout the empire. Some shoes had hobnails placed evenly apart, dispersed throughout the surface of the outer sole, while other shoes had hobnails placed in no discernable pattern. Throughout the empire, shoes with exquisite patterns have been recovered. Such shoes placed emphasis on the decorative element of hobnails, rather than the structural integrity. At military sites such as Vindolanda, patterned hobnail shoes include some highly decorative examples but also many with a simple linear pattern of evenly placed hobnails.

[123] For case studies of 3D imaging application in Roman archaeology and specifically Roman shoes at Vindolanda, see M. Glanfield 2023's forthcoming thesis at Western University.

Due to the state of the shoes recovered, a simple visual inspection would not accurately determine where most pressure was applied during walking, and thus specific patterns of walking are difficult to decipher based on imprints on the insole. Bulging uppers, a sign of pigeon-toed walking (feet facing inwards), a condition seen on historical archaeological footwear, cannot be reliably identified in assemblages such as at Vindolanda because of the heavy dirt that compressed the shoes throughout the centuries before excavation, thus precluding the study of uppers as a method of determining gait.[124] As a result, the shoe soles and the modifications to them are the only parts that can be studied to determine foot issues in this ancient population.

3.5. Results

In the assemblage as a whole, five different modification types were identified. Some of the modifications would have been placed during manufacture. Others, belonging to a more "do-it-yourself" category, could have been added any time post-production.[125] The details of each modification type are elaborated below. Of the 423 shoes from the Severan ditch, only 7 show evidence for some form of shoe modification. This means approximately 2% of the Severan ditch shoes show modifications.

There are a few possibilities why such a small number of shoes were modified: altered shoes may have been important enough to travel with (instead of discarding them in the ditch); there could have been a limited number of people who could modify shoes (from which we must conclude that a large portion of the population did not have

[124] Pigeon-toed shoes have been observed at sites such as the historical site Mill Creek in Boston, Massachusetts (White 2009), and Medieval London (Grew and de Neergaard 2001).

[125] One interpretation of pre- or post-production modifications is to view them as corrective versus pre-emptive modifications.

access to this technology); or simply few people may have needed modifications. The different types of shoe modifications are defined below in this chapter, while the broader analysis of the group of modified shoes will be discussed fully in chapter 4.

Modification Type	Modified Shoes	Number of Shoes
Orthotic Metal Bars	L-1991-2800, L-1991-2894, L-1991-3170, L-1992-3745, L-2001-69, L-2005-67A, L-2007-36A	7
Supplementary Hobnails on Tread Sole	L-2016-153, L-2016-159, L-2016-191, L-2016-334, L-2017-52	5
Additional Leather Pieces	L-1994-4242, L-2002-257A, L-2016-27	3
Bronze Disks on Insole	L-2001-49, L-2002-217A, L-2016-27, W-1987-398	4
Iron Studs on Insole	L-1988-2023, L-1994-4242, L-2016-163, unmarked pre-1973 shoe	4

Table 3.2: Table categorizing the five modification types, which shoes belong in each category, and the total number of shoes in each category. Some shoes have two types of modifications and are listed in each category.

3.5.1. Orthotic Metal Bars

Seven of the shoes in the case study have metal bar attachments or plates. The orthotic bars are attached to the tread sole via a hooked end that was hammered into place between sole layers. The hook rested between sole layers, not coming in direct contact with the foot. There were at least two attachment sites per bar, though one was found which had three separate attachment points (L-1992-3745). The metal bars appear to have been added in post-production and were not a part of the original shoe plan. The easiest way to determine at what stage the bars were applied is to see their relationship to the hobnails around it: if they are placed over the studs, then that suggests they were added later in the process. If, on the other hand, they had been added during the creation of the shoe, then the shoemaker would not have used studs where the bars were to be placed. Doing so would be a waste of hobnails that could otherwise be used elsewhere.

Of the six metal bar modifications, five are still attached to the shoe soles and can be reliably sided. The metal bar found on L-2005-67A, on the other hand, is detached from the shoe. Three shoes have bars placed on the lateral edge of the heel (L-1991-2800, L-1992-3745, and L-2001-69). Only the lower portion of the shoe from the waist to the heel is preserved on one example with an iron bar (L-1991-2894), which makes it a challenge to side since the direction of the toe is missing. If it is a left shoe, then the bar is placed laterally, and if it is a right shoe, then the bar is placed medially. The shoe L-2007-36A features the only bar that encompasses the entirety of the heel (fig. 3.4).

Two of the orthotic modifications (one bar, one metal plate) are no longer attached to the shoe soles in which they were first placed. Despite this, the approximate location of the modifications is possible. The metal plate orthotic (L-1991-3170) is no longer attached to a shoe, but based on the angle, the plate was probably located between the tread and toe portion of the sole (fig. 3.5; see fig. 3.6 for the possible location of the metal plate on a shoe sole). The metal plate was identified as a shoe modification based on the holes it is fitted with, which would have allowed hobnails to connect the plate to the outer sole, and the few actual hobnail heads that remain in the fragment. The metal plate appears to be fragmentary, with only a portion recovered during excavation. It may appear problematic to record the metal plate as a modification based on a fragmentary piece, but the fragment is still quite telling of an addition meant to aid the shoe owner in their pursuit of a better gait. Based on the other bar modifications, the bar that is no longer connected to a shoe (L-2005-67A) also must have been placed either medially or laterally encompassing the heel.

Figure 3.4: L-2007-36A. A metal bar is visible on the outer edge of the heel. Image copyright of Casey Boettinger and The Vindolanda Trust.

Figure 3.5: L-1991-3170. A metal plate that was placed on the outer sole. Holes where hobnails were placed to hold the plate in position are visible. The metal plate pictured here appears to be a fragment of a larger object. Image copyright of Casey Boettinger and The Vindolanda Trust.

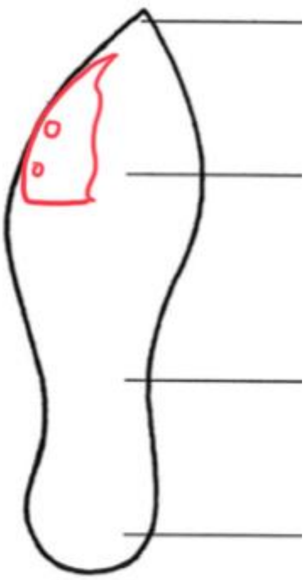

Figure 3.6: The red shape demonstrates where the metal plate may have been located on the tread sole. Image copyright: outline from van Driel-Murray 2007: 345, modified by C. Boettinger.

3.5.2. Bronze Disks on the Insole

Three leather shoes were found featuring flat, bronze disks on the insole of the shoe and a single wooden clog also includes this feature. The clog (W-1987-398) has one single disk placed at the centre of the heel, maintaining about 1cm of distance from the medial, lateral, and back edge of the clog. The same is true of the leather shoe L-2002-217A. One other shoe has bronze disks located at the heel area, though these bronze disks are located on either side of the heel, with one located at the central heel. The disk located medially is still intact but the lateral and centrally placed disks are missing, though their impressions remain. L-2016-27 has two visible disks, both located at the toe/tread area of the insole. This is the only bronze disk modification that has disks located in the upper half of the sole.

Apart from the wooden clog, all the shoes have the bronze disk(s) situated right along the border of the sole. Only the clog leaves a significant amount of space surrounding the disk. The disk on shoe L-2016-27 appears to almost extend past the perimeter of the sole. It would seem that there was no standard location for the placement of these disks on the insole.

The disks differ in quality and size, with the best-preserved disk on a sole that is also stamped (fig. 3.7). Stamps were used to mark a shoe as a higher quality product than other common items of footwear.[126] Shoes such as L-2002-217A and L-2001-49 have disks that extend quite a bit higher above the insole than those from shoes L-2016-27 and W-1987-398. This may simply be a result of an accumulation of dirt and other natural materials that can congregate on artefacts over time.

[126] Greene 2019. Greene writes that the maker's mark could be used for quality control purposes or to show pride in one's work.

Figure 3.7: L-2001-49. Red circles show areas where the bronze disk modifications are located throughout this category. Image copyright of Casey Boettinger and The Vindolanda Trust.

3.5.3. Iron Studs on Insole

Much like the bronze disks were attached to the surface of the insole, some of the shoes in the assemblage have iron studs that look more like the hobnails typically used on the outer sole but have been nailed into the insole. These studs differ from the bronze disks not only in material, but also in size and height relative to the rest of the insole layer. The iron studs would have been much more noticeable to the wearer than the flat bronze disks. It is tempting to suggest that the added studs were necessary for holding the shoe together, but the sole layers were held solidly intact by the outer sole studs, so there would be no need to place hobnails in the insole for this purpose. Another explanation, therefore, is required.

With the exception of L-1988-2023 (fig. 3.8), all the iron studs in this modification type are located along the border of the shoe soles. In L-1988-2023, two studs appear around 1cm from the border, both located at the medial edge of the tread. This is interesting to note, since all the other studs in this modification appear closer to the border of the sole. In shoes L-1994-4242 and L-2016-163, the iron studs are located at the waist, both oriented medially. In L-1988-2023, there are five visible studs, though a sixth was also likely present. The medial tread has the two studs noted above, and three (possibly four) that are located on the lateral tread area. Evidence for a fourth stud comes from a hole located along the edge of the perimeter of the lateral tread area. This could have been where a stud was hammered into the shoe. The studs on this shoe are particularly raised and look as if they would have easily been felt when pressure was applied by the foot.

The unmarked pre-1973 shoe, which regrettably lacks any contextual information with which to date the object, has two remaining studs. An inspection of the insole suggests that in antiquity there were at least four, maybe five, other studs that created a border encompassing the heel. Studs appear to be more concentrated at the base of the heel rather than along the medial or lateral edges, which could suggest the wearer hit the ground hard with their heel and attempted to mitigate the pain caused by the force. The studs stop at the beginning of the waist and do not line up across from each other (from medial to lateral edge). This shoe also features stamps, suggesting it was a high-quality product.

Figure 3.8: L-1988-2023. Though this insole only has one stud, the red circles show where the iron studs are located on the other shoes within this category of modification. Image copyright of Casey Boettinger and The Vindolanda Trust.

3.5.4. Supplementary Hobnails

In this case study, only shoes from the Severan ditch were considered for the presence of supplementary hobnails. We already have known examples of shoes with additional hobnails outside this ditch context. Thus, comparisons surrounding the amount of each modification type are not possible for this category of modification since only shoes from Period 6B were considered. There are shoes with additional hobnails spread throughout many phases of occupation, not just Period 6B, which remained the area of attention for this case study.

Observing hobnail patterns is a most useful method for understanding the types of walking patterns that people exhibited. Maya Veres notes that a common method of shoe repair involves adding nails into the sole to increase the length of wear.[127] In such a practice, nails were often placed around the sole with an extra row at the toe and the

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[127] Veres 2005.

joint.[128] Since some shoes at Vindolanda already had established patterns of hobnails on the outer sole, any disruption of the pattern suggests a conscious decision to turn away from the original design. The addition of hobnails grouped together in particular areas suggests that these locations were worn through first and needed to be repaired to make the shoes last longer and perhaps mitigate the gait issue causing that wear.

Of the five shoes with supplementary hobnails, three of them had hobnails grouped at the very edge of the toe. One shoe, L-2017-52, had additional hobnails along the medial edge of the tread, where the big toe would have been situated. Despite the poor preservation of L-2016-159, a significant grouping of hobnails can be observed at the medial side of the heel (fig. 3.9). It is quite difficult to count the hobnails in the group because of the preservation, but a conservative guess is that there were 12 hobnails tightly nailed together.

Two shoes, L-2016-334 and L-2016-153 have multiple groupings of hobnails (see fig. 3.10 for where the modifications occurred in this category). In both shoes, the toe is filled with hobnails. Just as the metal bars encompass one half of the heel, so too do the hobnails cover the span of half a heel on L-2016-153. In L-2016-334, a few strategically placed hobnails support the medial side of the upper heel.

[128] Laurence-Lord 1948.

Figure 3.9: L-2016-159. Despite the poor state of preservation, a grouping of hobnails is visible at the medial side of the heel. Image copyright of Casey Boettinger and The Vindolanda Trust.

Figure 3.10: L-2017-52. The red circles show where the groupings of hobnails appear on the shoes in the modification category. Image copyright of Casey Boettinger and The Vindolanda Trust.

3.5.5. Shoes with Additional Leather

Finding shoes with additional leather between sole layers can be quite difficult if observation with the human eye is the only method of detection. In most of the leather shoes in this study, the multiple layers that comprise the sole were still quite well attached to each other, which means that scraps of leather added between layers could not be discerned. Two soles were found with added pieces of leather (L-2016-27 and L-2002-257A) and one shoe had fantastically thick leather soles (L-1994-4242). There are likely more shoes with this addition, but identification is hindered by the fact that most shoe sole units remain intact, and the midsole layers cannot be seen.

L-2016-27 and L-1994-4242 were previously identified as having modifications. These two shoe soles were already being examined closely for their obvious modifications, namely bronze studs on insole in the former, and iron studs on the insole for the latter, so it was by chance that they could be studied at all for this modification type. Since it was not possible to look over every shoe from the Vindolanda assemblage, only shoes with previously identified modifications, or those from the Severan ditch, could be considered. It is very likely that if all the shoes in the assemblage were thoroughly examined there would be more examples of shoes with additional leather.

On shoe L-2016-27, the additional piece of leather is located at the top of the tread area, at the medial side of the shoe (fig. 3.11). This is near where the big toe would have sat while walking. In the case of L-2002-257A, however, the additional leather is located on the lateral edge of the tread, directly opposite to L-2016-27. Both pieces of leather are in the tread area, a zone that bears much pressure when walking.[129]

By far the thickest shoe sole encountered in this case study is that belonging to shoe L-1994-4242. Both by holding and looking at it, it is obvious that the sole layers are much thicker than the norm. None of the other shoes in this study came close to weighing as much as this one sole. This shoe also featured the iron studs from an insole modification, suggesting that the owner had a particularly bad foot.

Figure 3.11: L-2016-27. A small piece of leather is visible between the sole layers, attached by a hobnail. Image copyright of Casey Boettinger and The Vindolanda Trust.

3.6. Conclusion

This chapter began with an introduction to Vindolanda and the shoes which are located there. The military fort at Vindolanda boasts the largest assemblage of leather shoes

[129] Though I argue that the additional leather is an intentional modification, it is important to consider alternatives as well. To that end, the extra leather may in fact be the mark of a high-quality shoe, rather than a modification for the comfort of the shoe wearer.

from the Roman period because of the anaerobic conditions that predominate and preserve organic material. Five different modifications were observed on the Vindolanda shoes: metal orthotic bars, bronze disks on the insole, iron studs on the insole, supplementary hobnails, and shoes with additional leather between the sole layers. The first three modification types were observed throughout the entirety of the assemblage (3,340 shoes), whereas only the Severan ditch shoes (423) were examined for supplementary hobnails and additional leather. Each type of modification was listed and briefly described, accompanied with images that best reflected the modification. While most shoes only had one type of modification, there were a few where more than one alteration or addition was found. The goal of this chapter was to provide background information about Vindolanda and the shoe modifications. The final chapter takes this information and provides discussion based on these results.

CHAPTER 4:
Discussion and Conclusion

4. Introduction

Shoes have long been a part of everyday life, and as such, they come up in popular sayings. As White observed, "maxims regarding the intimacy of shoes abound in modern parlance: 'if the shoe fits, wear it,' 'walk a mile in someone else's shoes.' As artifacts, shoes carry the marks of the individuals who wore them in many different ways, physically as well as symbolically."[130] Van Driel-Murray had the same thought when she wrote that "shoes are deeply personal: they preserve the imprint of the soul."[131] Grew and de Neergaard wrote about the consequences of wearing ill-fitting shoes during the formative years of childhood: "many of the disorders which become noticeable only in old or middle age can be attributed to the wearing of incorrectly-fitting shoes when young. A child's foot is not fully formed before the age of about eight years, and even a soft shoe can deform it without causing obvious discomfort."[132] Unaware of the consequences of wearing improper footwear, those that grew up and developed foot issues had to rely on additions to regular shoes to provide support where they lacked it. From our earliest days, the act of wearing shoes left marks on our bodies. We, too, left impressions on our shoes.

Shoe modifications reveal the importance of foot health through time. Most people either pronate or supinate when walking and only about 30% of the population

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[130] White 2009: 141.
[131] Van Driel-Murray 1999: 135.
[132] Grew and de Neergaard 2001: 106.

has a neutral gait.[133] Having a neutral gait was seen as so important that up to recent times, men would be excused from the army if they were flat-footed.[134] While there are no writings about men being dismissed from the Roman army based on the way they walked, men were required to be in good general health.[135] Certainly, it is not a leap to consider that a soldier needed to be in good health to perform the physical duties required of the job. The shoe modifications at Vindolanda exemplify ways in which soldiers and civilians sought to correct their gait and have better foot health.

The final chapter of this thesis begins with a description of gait cycle and the different types of gaits that can be found in a population. The five shoe modifications discussed in chapter three are discussed in further detail, with their purpose divided into three distinct categories. Additional information that can be gleaned from studying the shoe assemblage is discussed, including who amongst this population had access to podiatric knowledge. Using information from modern podiatry, both forensic and as a health care practice, I question what can be discerned about Roman podiatric knowledge.[136] Discussion of the modified shoes draws heavily from Grew and de

[133] Foot Health 2022: https://orthomovement.com/en/foot-health/?market_id=1. A neutral gait is one where the outside of the heel strikes the ground first, followed by the weight being distributed evenly across the ball of the foot.

[134] Bledsoe 2022. The army thought that those who have flat feet would injure themselves marching and hiking. There was a shortage of soldiers during the Vietnam War (1955-1975), which caused the flat-footed disqualification to be overturned.

[135] Stout 1921: 425 wrote about the physical requirements of a Roman soldier: he should have "observant eyes, hold his head up, have a broad chest, muscular shoulders, strong arms, long fingers, not too extended a waist measure, lean hams, and calves and feet not distended with superfluous flesh but hard and knotted with muscles." Vegetius, who provides the description of what to look for in a soldier, goes against the height requirement set out by Marius, who says that a soldier ought to be 5 feet 10 inches in Roman measure. Vegetius, instead, believes that a soldier can be short, as long as he meets the requirements for strength that a muscled physique shows.

[136] Approaching past practices through a modern lens can be fraught with issues. Unfortunately, it is only through modern information that we can begin to understand the theories behind certain shoe modifications. Other subdisciplines face the same issue of treating ancient material through a modern understanding and must frequently defend themselves. Fashion historians, for example, must use modern theories to understand the way that people dressed in the past. This is because they do not have written sources to consult, and often do not have ancient textiles, either.

Neergaard's work on Medieval era shoes from London and Greene's work on modified shoes at Vindolanda.[137]

4.1. The Gait Cycle

The gait cycle can be thought of as the process of one foot striking the ground, lifting, and striking the ground again. During the gait cycle, the lower limbs are either in a stance phase or swing phase.[138] The former occurs when any part of the foot is in contact with the ground, and the latter when the foot is not in contact with the ground. In the gait cycle, the stance phase makes up about 60% of the cycle, the swing phase, about 40%.[139] Bonnefoy-Mazure and Armand explain the further division of the gait cycle:

> It is possible to make a sub-division according to the stance and swing phase of the two lower limbs. When both members are in stance phase, this is a bipodal support (or double support) and when one of the two members is in stance phase while the other is in swing phase, this is a unipodal support (or single support.)
>
> More specifically, the stance phase can be divided into five functional sub-phases occurring in the following sequences: initial contact (IC), loading response (LR), midstance (MSt), terminal stance (TSt) and preswing (PSw). The stance phase is divided into three functional sub-phases occurring in the following sequences: initial swing (ISw), mid-swing (MSw) and terminal swing (TSw).[140]

[137] Grew and de Neergard 2001; Greene 2019.
[138] Bonnefoy-Mazure and Armand 2015.
[139] Bonnefoy-Mazure and Armand 2015.
[140] Bonnefoy-Mazure and Armand 2015: 200.

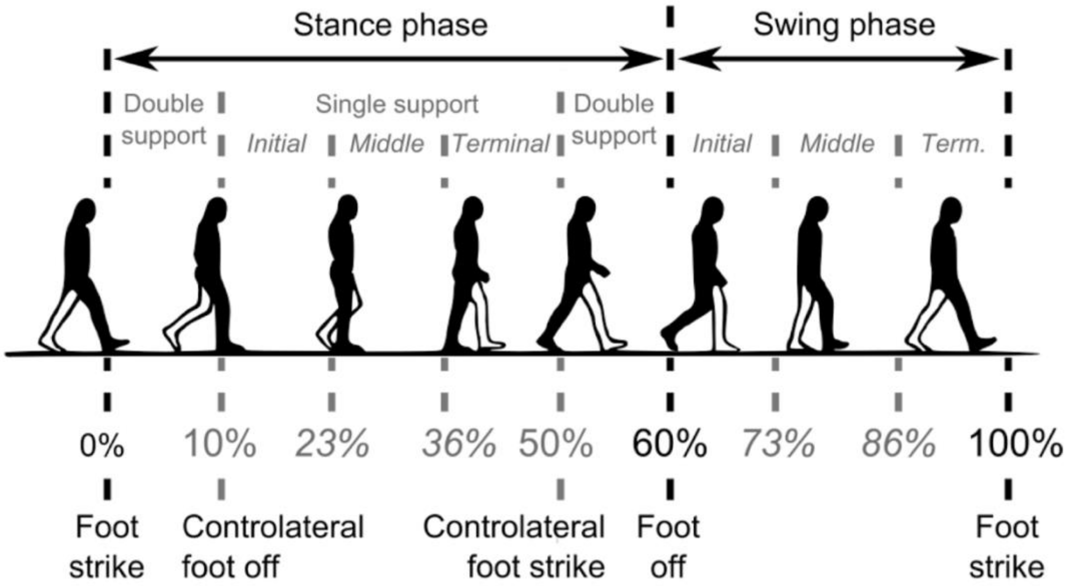

Figure 4.1: Image of the gait cycle. From Bonnefoy-Mazure and Armand 2015: 200.

The lower limbs (everything from the hips to toes) are meant to perform three functions: weight acceptance, single-limb support, and limb advancement.[141] While walking, there are certain ways that a foot can strike the ground which affects the overall process of walking. Gaits can be neutral, oversupinated, or overpronated. There are varying degrees within those categories, but for ease of explanation, more extreme gaits are described below.

First, a study conducted by Ren, Jones, and Howard on predictive modelling of the gait cycle demonstrated how stiff-kneed, inadequate knee extension, and excessive ankle plantar flexion gaits affected the energy expenditure of walkers.[142] Their work showed that those who walk with non-neutral gait spend more energy than those who walk with a neutral gait. For individuals with gait issues who spend hours walking or

[141] Perry and Burnfield 2010.
[142] Ren, Jones, and Howard 2007.

marching, the amount of extra energy expended just to reach the same distance as those with neutral gaits adds up. This demonstrates how something as insignificant seeming as a droopy foot can affect the rest of the body, causing more calories to be burned than otherwise would be. A higher energy expenditure requires a higher caloric intake to maintain, so if individuals were not consuming enough calories to make up for what they were expending through their day-to-day activities, issues such as fatigue or sickness could arise.

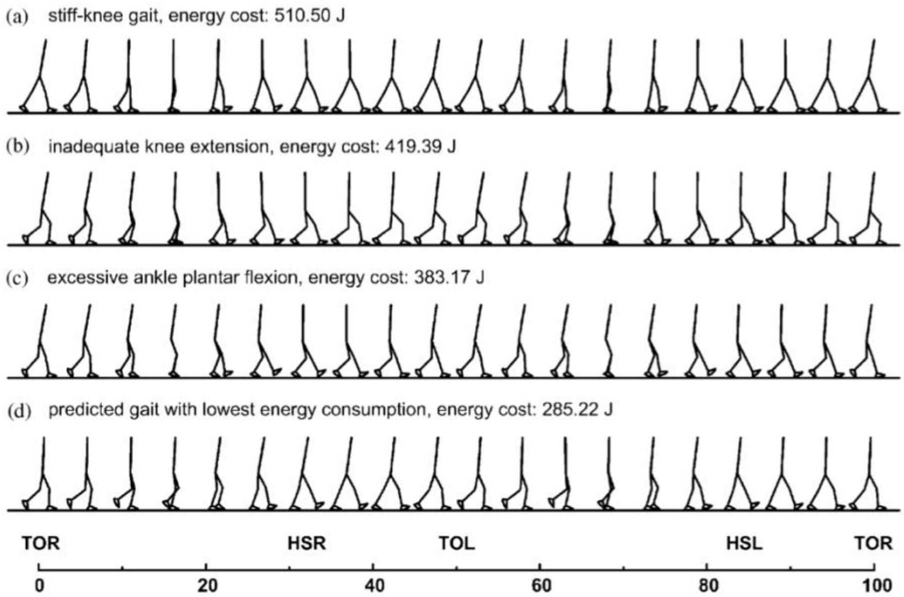

Figure 4.2: Image showing the energy costs associated with four different types of gaits. From Ren, Jones, and Howard 2007: 1572.

4.1.1. Types of Walking

There are three main types of walking: walking with a neutral gait, a pronated gait, or a supinated gait. In a neutral gait, the outside of the heel strikes the ground first, with the weight transferred along the foot up to the toes. Grew and de Neergaard provide the following explanation of a "normal gait":[143]

> The feet are complex levers, made up of many small moving parts which are subjected to heavy loads. For this reason, minor variations in gait are common, as are malformations of the feet themselves… In normal walking the first point to touch the ground is the back of the heel on the outer (lateral) side, for the structure of the ankle and leg joints is such as to cause the foot to point outwards, at an angle of about 5 degrees to the direction of walking, at the beginning of each step. From there the foot rolls inwards slightly to transfer the weight squarely across the metatarsal heads, the 'ball' of the foot; and, finally, contraction of muscles in the calf and in the foot propels the body forward, flexing the metatarso-phalangeal joints at the base of the toes and pressing the tips of the toes onto the ground.

In an overpronated gait, this weight transfer occurs unevenly across the medial aspect of the foot, and over time can cause the arches to fall, creating what is called 'flat foot.'[144] According to Hadyn Kelly, "pronation [is the] motion of the foot articulations that allow the foot to become more prone to the support surface thereby increasing the ground contact surface area of the foot."[145] Overpronation can be determined by excessive wear on the medial edge of the shoe, especially at the heel and toe areas of the foot.

Oversupination is rarer than overpronation. An oversupinated gait is one that privileges the lateral edge of the foot. An oversupinated gait leads to reduced ability to

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[143] Grew and de Neergard 2001: 106.
[144] https://my.clevelandclinic.org/health/diseases/22474-overpronation. The Cleveland Clinic provides a list of symptoms one might face if their overpronation is serious: bunions, heel pain, inflammation of the ligament on the outside of the knee, shin splints, hip pain, knee pain, and back pain.
[145] Kelly 2020: 43.

absorb shock because the shock cannot be distributed as well to the fleshy side of the foot.[146] Pronation allows the foot to absorb shock through the amount of contact it makes with the ground. If a person oversupinates when walking, the stresses that are normally faced when walking cannot be effectively absorbed by the inside foot and are passed up through the lower limb. Oversupination also causes increased lateral rotational force that is passed on to the shin, knee, and thigh. This places undue stress on the muscles, tendons, and ligaments.[147]

How one walked during life can be determined by studying the wear marks left behind on their shoes. Modern podiatrists may have patients walk down a hall so they can observe the angle of foot connection with the ground, or they may look at the outer shoe sole. It may be challenging in archaeological contexts to study wear patterns on shoes with eyes alone. Taphonomic processes may preclude such a study, or even something as mundane as dirt collection and discolouration can inhibit a researcher's ability to look at insoles to see what parts of the foot were pressing most into shoes. For the Vindolanda shoes, only outer sole wear is considered.

4.2. Types of Modifications

The five types of shoe modifications in this study can be broadly categorized into functional or accommodative adaptions, which differ in a few ways. Functional adaptions are designed to provide support, while accommodative adaptions seek to alleviate pain or foot deformities.[148] While some of the modifications may have features

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[146] Walden 2023. https://www.sportsinjuryclinic.net/treatments-therapies/foot-biomechanics-gait-analysis/over-supination-foot-biomechanics.
[147] Walden 2023. https://www.sportsinjuryclinic.net/treatments-therapies/foot-biomechanics-gait-analysis/over-supination-foot-biomechanics.
[148] Kermen and Mohammadi 2021.

of both adaptions, the final placement of the modification types is based on the assumed primary function of the modification. Thus, categorized under "functional adaptions" are the orthotic metal bars and additional hobnails modifications, and under "accommodative adaptions" are the supplementary leather, bronze disks on insole, and iron studs on insole modifications.

4.2.1. Functional Adaptions

Two modification types, namely orthotic metal bars and additional hobnails, appear to have been used to help correct or minimize gait issues.[149] Both of these modifications can be called functional adaptions as they provide support for the foot while walking. These modifications would prevent the foot from rolling too far inward, or outward, depending on the issue and the placement of the modification device. For the majority of modifications, additional hobnails are placed medially, whereas most of the metal bars are located laterally. The sample size is too small to make any determinations about the prevalence of overpronation versus oversupination, but it is interesting to see that the treatment for one or the other seems to be reflected in which modification was used (metal bars or hobnails).

By placing a bar at the heel of the shoe, pronated or supinated gaits could be altered.[150] The bar situated on just one side of the heel would slightly adjust the angle at which the heel and, therefore, the foot, would encounter the ground. The placement of a bar on one side meant that the foot would distribute weight evenly across the sole, as the slight adjustment would allow the foot to meet the ground more evenly, thus

[149] Greene 2019.
[150] Greene 2019.

creating a comfortable gait for the wearer. In this case, bars set into place on the outer sole worked much the same way as modern orthotic inserts. Modern inserts manipulate the distance from the foot to the sole of the shoe, which changes the angle at which the foot impresses upon the ground.[151] Whether the muscles or bones are targeted with orthotics is an issue that is up for debate, with clinicians still uncertain as to what exactly is corrected with orthotics.[152] Regardless of what is being affected, many have found that wearing orthotics helps to alleviate gait issues. Though modifications were made to the outer sole in the Vindolanda sample and to the inside of the shoe in modern samples, their ultimate function is the same: both seek to correct an imbalanced gait by changing the angle of the foot interacting with the ground.

[151] There have been numerous studies testing the validity of using inserts to adjust the way a person walks. Nester, van der Linden, and Bowker 2003 study the effects of orthoses on gait patterns, suggesting that inserts do in fact alter gait for a more comfortable walking experience, dependent on which side they are inserted (medially or laterally) to suit the individual. Some other studies that have researched the effectiveness of orthotics are Blake and Denton 1985; Sasaki and Yasuda 1987; Donatelli, Hurlbert, Conaway, and Pierre 1988; and Moraros and Hodge 1993. There are, of course, others, but this serves as a place to begin looking at the efficacy of orthotic use.
[152] Collier 2011.

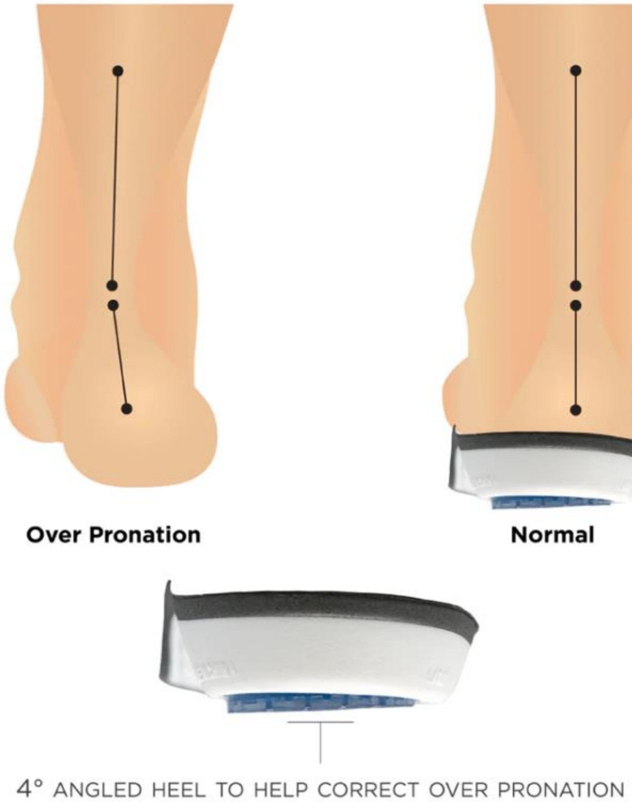

Figure 4.3: A demonstration of how modern orthotic inserts adjust the angle of the foot interacting with the ground. From https://harris-active.co.uk/products/tulis-plantar-fasciitis-insoles.

Shoes that would otherwise unevenly wear down because of a non-standard gait could be fitted with extra hobnails to bolster areas that needed it. These shoes that had additional hobnails placed in strategic locations, such as the distal edges of the sole, would change the way in which a person's foot came into contact with the ground, like the orthotic metal bars above. By supporting targeted areas with additional hobnails, not only would the wearer's gait be affected, but there would be an added benefit of extending the period in which the shoe could be worn. Every form of walking will, over time, create wear on shoes. It is an unavoidable consequence of using them. The primary goal of applying more hobnails into the shoe would be to produce a method for correcting how the owner walked. By using these hobnails, however, the owner additionally profited from mitigating extensive wear on one area of the sole and not having to replace their shoes as often as otherwise needed.

Additionally, L-1991-3170 features a metal plate rather than a metal bar. It is only fragmentary and detached from the shoe, but based on the curvature of the plate, it has been suggested that it was attached to the tread area with hobnails. This plate could have been put in place to support someone with 'drop foot,' a condition in which one finds it difficult to lift the front part of the foot.[153] Modern methods of treating this condition involve wearing braces on the ankle and foot to provide support. There may have been familiarity with the condition in antiquity, and perhaps the easiest way to manage the condition was to add a plate to support the foot that was dragging along.

4.2.2. Accommodative Adaptions

Padding is an accommodative measure which targets specific areas of the foot that hurt while walking. The tread area is a common location for padding. Both observed pieces of padding in the case study are in the tread area, at opposite ends. The added leather piece on L-1994-4242 is located on the medial side, rather near to where the big toe would be situated. One such condition which would benefit from this modification is *Hallux rigidus*, otherwise known as arthritis in the big toe. This condition was first described in the 1880s and affects the toe when pressure is applied, such as in walking.[154] *Hallux rigidus* would be alleviated by the cushioning provided by an additional leather strip necessary for extra comfort when stepping. Bunions would also cause pain while the foot was confined in shoes during motion.

[153] "Foot drop" from https://www.mayoclinic.org/diseases-conditions/foot-drop/symptoms-causes/syc-20372628.
[154] Patel 2021 from https://www.ncbi.nlm.nih.gov/books/NBK556019/.

The other shoe with an additional leather piece, L-2002-257A, indicates that another area of pain was under the *digitus minimus pedis* (fifth toe). Pain in this area can be caused from increased pressure through the toes because of bunions on the medial aspect of the foot, or because of bunions on the outside of the foot (called a bunionette or tailor's bunion).[155] Calluses can also form in this spot if there is too much pressure along the tread when walking. Treatments for such conditions were written by Greek and Roman medical doctors, so perhaps this was a solution for someone who did not wish to undertake medicinal or surgical options.[156] These additional leather pieces would have been added at the time of production, which means that the wearer must have known of their foot problems and communicated them to the shoemaker. Once the manufacture of a shoe was complete, the sole layers would not be pried apart to add in additional pieces. If a foot problem developed after the creation of the shoe, then the wearer could either ignore the discomfort and wait until their next pair of shoes to address the issue, or they could develop their own remedies.

If a small scrap of leather were not enough to provide some comfort, then shoes with extra thick sole layers could be worn. Four extremely thick layers of soles on L-1994-4242 add significant weight to the shoe but would have cushioned the feet as the wearer walked. The thickness of the soles suggests that this individual may have needed to mitigate the painful effects of walking. These robust soles, which are unusually thick compared to similar sole units in the assemblage, could have functioned as shock

[155] From https://www.health.harvard.edu/pain/what-is-a-tailors-bunion.

[156] Celsus, *Med.* book 5.28.14 provides the following treatment for corns: "a corn is best scraped down from time to time; for thus, without any violence, it softens, and if also a little blood is let out, it often dies away." Translated by W.G. Spencer, 1938. Most remedies for sore feet involved the mixing and later application of herbs to the feet. In the third century CE, however, Clement of Alexandria writes that rubbing the feet with unguents is beneficial for treating foot issues. See Irby-Massie 2009 for more information, as well "Archilochus, Semonides, Hipponax" 1999, translated by Douglas E. Gerber.

absorption devices, meant to make mobility a more comfortable pursuit.[157] While the arch of the foot already functions as a shock absorber, sometimes additional support is needed. These soles could muffle the force felt when feet strike the ground.

Grew and de Neergaard write "it is often thought that certain individuals have a natural propensity to the condition (*Hallux rigidus*), perhaps only because their feet are disproportionately long, but it can be exacerbated by narrow, pointed or badly-fitting footwear."[158] This is interesting to consider because, certainly, shoes at Vindolanda could be made-to-order or ready-made. The leather pieces inserted between sole layers discussed above reveals that the shoes had at least partial customization based on the owner's preferences. If they were adding leather pieces to make the shoes more comfortable to wear, were they also able to request wider shoes? Poor shoe fit must have accounted for a percentage of foot issues at Vindolanda, meaning that not every modification can be said to have arisen as a treatment for pre-existing health conditions.

Aside from the use of padding as an accommodative modification, the iron studs on the insole also appear to have acted as a means to alleviate pain. I hypothesize that the iron studs added to the insole of the shoe may have functioned as a massaging device while walking.[159] The iron studs were raised a significant enough amount from the insole that they would have been acutely felt by the wearer each step they took. The wearer of the shoe would have felt the slight presence of the studs each time their steps

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[157] Johnson 1988 conducted a study of insole inserts (nine different types) to measure the effectiveness of their shock absorbing capabilities. The conclusion reached was that "statistically significant shock reductions can be achieved by insoles and that their effectiveness is greatly influenced by the footwear in which they are used" (94). Perhaps the thick sole layers functioned in a similar way.

[158] Grew and de Neergaard 2001: 111.

[159] This idea comes from my own experience wearing shoes that have gotten pebbles stuck in them. It seems a reasonable supposition that a modification that involves such a nuisance as the pain inflicted when stepping on something means that pain was the purpose of the studs. This line of thinking led to the idea that the modification was purposely meant to tenderize the skin, in an approximation of massage.

met the ground, as pressure was applied from their foot into the sole of the shoe. When pressure from the foot was applied across the sole, and especially against the iron stud, it would generate a form of friction movement, which is a type of massage. Melodee Harris describes types of massage that are used today and defines friction movements as "moderate, constant pressure to one area [that is] made with the thumbs or fingers."[160] This form of massage may be concentrated on specific areas or cover the expanse of the foot. Since the iron studs were immobile once placed on the insole, they would only have affected distinct areas of the foot. The intense pressure placed on the sole of the foot while walking and wearing these shoes would have had a deep massage-like function. Prapasri Jirayingmongkol et al. concluded that massage is beneficial for promoting good blood circulation, relaxation, and comfort and it is possible that these benefits were also understood in the Roman period.[161]

It would not be surprising to learn that Romans, like other ancient societies, used massage as a medical treatment. Hippocrates, Celsus, and others note the benefits of massage for loosening muscles, relieving pain, healing injuries, and correcting joint dislocations.[162] While massage with oils and aromatics is mentioned in both The Iliad and The Odyssey as a means of relaxing and healing warriors, it is Hippocratic medicine that first fully describes the idea of massage for healing purposes.[163] Massage was used to treat a variety of ailments, ranging from dislocations to deafness. The use of massage as a technique for treating shoulder and knee dislocations – pathologies that are often

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[160] Harris 2014: 260.
[161] Jirayingmongkol et al. 2002. Their study followed 20 adults who received foot massage from trained professionals. Their study showed that pulse rate, respiratory rate, and blood pressure all increased after receiving the massage.
[162] See Iorio, Marinozzi, and Gazzaniga 2018 for an introduction to the many uses of massage in Greek and Roman contexts.
[163] Iorio, Marinozzi and Gazzaniga 2018.

recurring problems – is mentioned in the Hippocratic texts.[164] To cure deafness, one could look to the book on *Epidemie* (Epidemics), where massage is used to cure a cook.[165]

Hippocratic therapies relied not only on massage to provide frictive movement, but also on wrestling and other forms of exercise. These were all thought to heat the surface of the body and allow ill humours to be released. Iorio et al. explain the use of frictive movements thus: the movements "force the external parts of the body to make a useful effort, warming the tissues, solidifying and developing muscle mass, condensing – through the movement – the parts of the body that according to nature are compact, adding volume to those that are deeper, such as the veins."[166] Massage was used as a way to heat the body through the friction generated through vigorous or deep rubbing, a treatment that was believed to generate healing results. A similar heated feeling would be generated over time as a person continually had pressure applied to the areas of the foot that lined up with studs on the insole.

Two ancient societies, Egyptian and Chinese, have been studied extensively because of their prominence in the past and their impressive medical knowledge and both practiced what can be considered "reflexology," "pressure point therapy," and massage.[167] Blunt defines reflexology as "an ancient form of natural healing that utilizes pressure on the soles of the feet to evoke a change in flow of energy through the body."[168] By expanding the field of study into other ancient societies, the goal is to gain a stronger understanding of the ways in which foot health was accomplished in the past,

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[164] Iorio, Marinozzi and Gazzaniga 2018.
[165] Iorio, Marinozzi and Gazzaniga 2018.
[166] Iorio, Marinozzi and Gazzaniga 2018: 60.
[167] For Ancient Egyptian medical practices see Nunn 1996; Ebeid 1999; Eltorai 2019.
[168] Blunt 2006: 257.

with the hope that a study of these other societies will reveal new ways to think about Roman foot care.

There is demonstrable evidence for Egyptian knowledge of medicinal practices being passed onto Greek physicians.[169] Hippocrates studied medicine in Egypt and had access to teachings that were hundreds, if not thousands of years old during his tenure there.[170] He learned of, and brought back, ancient Egyptian knowledge and used it to inform his own medicinal practice in Athens and beyond.

While it is highly evident that Egyptian knowledge was passed on to Greeks and Romans, the same cannot be said of traditional Chinese medicine transferred to the Roman world. Though there is evidence of Sino-Roman relations, much has to do with indirect trade of goods such as spices and silk.[171] This thesis does not seek to insinuate any connection between Chinese practices and Roman knowledge, but rather understands that ideas of foot care do not strictly belong to one culture. It is beneficial to study the variety of ways that foot care was practiced by others, so that new ideas can be considered.

In Egypt, evidence for foot health comes from tombs. El-Kilany wrote that the earliest depiction of foot massage comes from the Fifth Dynasty (approximately 2465 – 2325 BCE) tomb of Ptah-hotep in Saqqara.[172] There are two scenes from the Sixth Dynasty (approximately 2345 – 2181 BCE) tombs at Saqqara that depict the process of

[169] El-Gammal 1993 notes the history of Greek invasion into Egypt and the knowledge obtained as part of their conquest. Among the knowledge that transferred from Egyptian to Greek physicians is that of women's diseases being caused by morbid states in the uterus. El-Gammal also connects the offering of cocks at sanctuaries of Asclepius to the offering of an ibis to the Egyptian god of medicine, Imhotep.
[170] Jouanna 2012 states that the chronological gap between the Egyptian papyri and Hippocrates' learning medicine in Egypt is not an issue; the papyri extend over a long period from the 1800s BCE until the Ptolemaic age, which was post-Hippocrates, without any major changes in the texts.
[171] For more information about the Silk Road and Sino-Roman relations, see McLaughlin and Kim 2021; Fitzpatrick 2011; Thorley 1971.
[172] El-Kilany 2016.

medical massage on the hands and the feet as a form of treatment.[173] El-Kilany's study focuses on depictions of high officials and commoners receiving foot massages. The first scene she discusses comes from the Tomb of Ankhmahor (a chief justice) and features medical practitioners on the left and right side of a client. The practitioner on the right handles the toe of the client who requests that they "do not cause pain to these." Their response to the client is "done to be praised by you, sovereign."[174] The massage scene is found on the east wall of room VI. On the opposite side of the room is a depiction of a young boy being circumcised.[175] Earlier work by Müller argued that room VI was self-contained and that both the circumcision and foot care scenes must have been depicting medical practices.[176] Later, Capart criticized this view, writing that circumcision was performed under the direction of barbers, not medical professionals.[177] Rather than room VI depicting medical services, Capart argued that the room simply shows scenarios that happened in life and that death mirrors the same events. El-Kilany countered Capart's argument by stating that massage was a medical treatment because of the text that accompanies the image. I find no issue with the idea

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[173] El-Kilany explains that scholars Ghalioungui, El Dawakhly 1965, Capart 1947, Kanawati and Hassan 1997, Nunn 1996, and Ebeid 1999 translated the writings that accompany the images to understand that the depictions of massage are medicinal instead of cosmetic, the latter occurring during manicures and pedicures. Nunn believes the phrase "do not cause pain to me" suggests a therapeutic effect is depicted rather than a pedicure.

[174] Nunn 1996: 133. Kanawati and Hassan 1997 translate the scene a little differently: "Do not cause pain to this." "I will do this as you wish, sovereign." A review of Kanawati and Hassan's book by Daoud 2004 states that most of the translations need thorough review and do not show complete command of the form of Egyptian that was used in the Old Kingdom. In this instance, the slight differences in translation between what Nunn writes and what Kanawati and Hassan translate is significant enough that it ought to be mentioned. Both the works, however, suggest that the scene is depicting medical massage, so that remains the focus of this discussion.

[175] Capart 1947.

[176] Müller 1906.

[177] Capart 1947: 52-53. In his words, "*"si nous n'avons en cet endroit que des scènes relatives au massage et au soin des ongles, il n'y a aucune difficulté. En acceptant l'interprétation du Müller, qui y voit des opérations chirurgicales, il n'en serait pas de même."*

that room VI can depict medical massage while also depicting surgery that is not performed by a doctor.

A votive stela from the Serapium of Saqqara dated to the early Ptolemaic period, around the 4th century BCE, provides another depiction of massage (fig. 4.4).[178] The stela reflects both Egyptian and Greek styles, which is in line with the population demographics at Memphis at this time. In the stela, an aristocratic woman is sitting on a throne and is attended by a young maid at her feet. The young maid, Omran suggests, is performing massage and reflexology on the aristocratic woman's left foot, while the right rests at the side for its turn to be massaged.[179] The funerary stela is a rare example of foot massage iconography; images of footcare are usually found in tombs and temples, and even then, they are difficult to come by. Foot-washing scenes tend to be reserved for the king, and thus the scene has been interpreted as massage, lacking any implements (such as nail clippers) that would suggest a pedicure.[180]

Depictions of foot care were created centuries before Greeks began to settle in Egypt and continued during their occupation. Numerous Greek doctors traveled to Egypt to learn medicine there, of which good footcare ought to be included.[181] These doctors learned ancient (even then) techniques to treat injuries and ailments. With their practical method of learning about client's ailments, their use of massage and

[178] Omran 2020. The stela is now housed at the Shibuya Egyptian Museum in Tokyo.
[179] Omran 2020.
[180] The *Heb sed* Festival featured a foot-washing ritual for the dead king, performed by the gods. The pharaoh could bath with Ra and had his feet dried by Horus and Thoth or could wash his feet in the sun god's silver basin.
[181] Jouanna 2012: 16-19. Jouanna notes the prevalent Greek attitude that Egyptian medicine was merely a shadow of Greek medicine, and that medicine was not truly discovered until Asclepius. Despite this attitude, Galen wrote of Egyptian doctors being the only ones successful in creating and using eyedrops and of Hippocrates' training in Egypt, which shaped the way he performed medicine.

reflexology to treat injury, and their prosthetics use, Egyptian society was well-advanced in their medical treatments.

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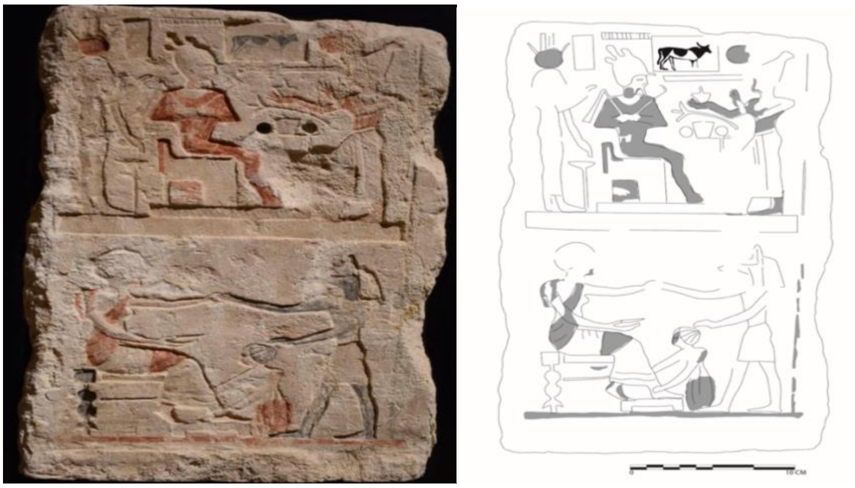

Figure. 4.4.: Images depicting foot massage on a funerary stela. From Omran's 2020 publication, *Publishing a funerary Stela in the Egyptian Museum in Tokyo.*

In China, evidence for podiatric knowledge in traditional Chinese medicine comes from the oldest known book on Chinese medicine, *The Yellow Emperor's Classic of Medicine,* though the description of massage within it is short and vague.[182] The text is written as a dialogue between Huangdi and his physician, as he asks questions concerning the nature of health, disease, and treatment.[183] According to Ni's translation of the text, massage is performed when a patient cannot handle acupuncture.

[182] Curran 2008 dates the creation of the book to around 300 BCE, though it is traditionally attributed to the famous Chinese emperor Huangdi around 2600 BCE. In truth, Emperor Huangdi is a semi-mythological figure, and the book is likely the compilation of several authors' writings. It may be wrong, therefore, to advertise the book as the "oldest known book on Chinese medicine" but I use the descriptor because the opinion of one author does not overshadow prevailing attitudes about the origin of the book.
[183] The book is split into two separate texts. The entire book is named the *Huangdi Neijing,* after the emperor who supposedly wrote it. The first section, the *Suwen,* covers the theoretical foundation of Chinese medicine. The second section, the *Lingshu,* discusses acupuncture in detail.

It is written thus: "Huang Di asked, 'How do you acupuncture in a mild condition?' Qi Bo replied, 'Massage is a good modality. Also take out needles and show them to the patient.'"[184] After the patient's body has been warmed up with massage, they undergo acupuncture treatment. By writing that acupuncture is to follow massage, the writer implies that massage is not the final treatment for injury/malaise, but that it is only one step of treatment. In traditional Chinese medicine, massage is the application of pressure to the body to help maintain good health and prevent disease. Unfortunately, not much is written about foot massage specifically, even though massage has a long history in China. Some scholars have traced massage as far back as the Shang dynasty (1600-1000 BCE), again suggesting that the *Huangdi Neijing* was written later than its traditional date of 2600 BCE.[185] Throughout the centuries, massage and physical activity have shared a close relationship, as evidenced by their shared name, *daoyin* (motion exercise).[186]

In traditional Chinese medicine, foot massage was based on one specific area of the foot (the centre of the sole), rather than many zones. Practitioners were encouraged to massage the centre of their soles first thing in the morning and again before going to bed. They were encouraged to massage themselves, though it was also acceptable for others to do the massaging. Sometime later, a wooden machine meant for foot massage was invented so that the process of massage could be automated. By stimulating and thus warming up the centre of the sole, it was believed that one could ward off *jiao*

[184] Ni 1995: 216.
[185] Fan 2006.
[186] Shen, Ding, Xu and Li 2018.

(foot) disease. This disease was thought to be caused by damp *qi* which invaded the body through the soles of the feet.[187]

Studying both Egyptian and Chinese practices of foot care in the past, it is clear that there is a long tradition of using massage to treat foot conditions. Both societies understood the value of massage as a tool to heal aches and to treat afflictions that arise from using one's legs. In much the same way, it could be that the iron stud on the insole modifications were meant to act as a massaging device to provide relief to the feet of those who were overtired and in need of extra attention. These iron studs would apply pressure against targeted areas of the underside of the foot when they were stepped on. Whilst uncomfortable in the moment, by the time the shoe was removed and pressure was relieved, the foot would feel tender and looser than before. The pressure and following relief may have provided the wearer with some comfort.

4.2.3. Skin Contact with Metal

The final shoe modification to be discussed is that which seeks to touch metal with skin. Evidence for the purpose of this modification is drawn from Greene's publication on podiatric knowledge, where she makes a compelling case for the purpose of the bronze disk and iron hobnailed insoles as a means of creating contact between the foot and metal.[188] I do not seek to offer an alternative to her idea here, except to add that the iron studded insoles may have functioned first as massaging devices with the benefits of metal on skin being secondary. Greene suggests that bronze disks on the insole may have been used specifically for their curative properties, in much the same way that

[187] Fan 2006.
[188] Greene 2019.

today some people wear copper alloy bracelets to alleviate joint pain and arthritis. To make her argument that the physical connection of foot to bronze was important because of the healing properties of specific metals, she references Pliny the Elder's *Natural History*, specifically books 33 and 34, in which he talks about the use of metal in medical treatments: iron, lead, silver, gold, and copper all have their specific uses.[189] Typically, the metals mentioned in his works are meant to be applied topically in a salve. It could be that some people decided, however, to skip the salve and instead apply the metal directly to their skin via nailing the inside of their shoes with disks and studs. They would then receive the perceived benefit of the metal, without having to remember to apply an ointment on themselves: placing metal in shoe insoles would have been a convenient way to assure that contact with skin could be achieved.

Though mentioned as a massaging device in the former section, it may be the case that the iron studded hobnails were also used to generate skin-to-metal contact. This could serve as a secondary function for the hobnails, with the primary use as a massage device. If the most important function were skin contact, however, it seems more likely that the hobnails would have been flattened into disks, much like the bronze ones. This would have saved the wearer the discomfort of feeling the raised hobnails so much. There were surely other ways for individuals to wear metal so that it interacted with their bodies, but it may have been most convenient for someone wearing the same shoes daily to modify them with specific metals.

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[189] Greene 2019: 321 includes references for metal - iron is found in Plin. *HN* 34.44-46; lead *HN* 34.50-51; silver *HN* 33.34-45; gold *HN* 33.25, 33.28; copper *HN* 34.23, 33.25-26, 33.28-32. Bronze is an alloy consisting of copper and tin – the former being one of the metals Pliny listed as containing curative properties.

4.3. Whose Shoes were Modified?

Aside from the modifications themselves, other information that can be learned from studying the altered shoes is the demographic of whose shoes were being modified. One issue we may face when considering the demographic of modified shoe ownership is that Vindolanda had many different people living in it. The Vindolanda shoe assemblage is comprised of shoes that belonged to anyone living on the site, which may have included soldiers, veterans, women, children, merchants and more. We can address the issue sometimes by using stylistic analysis on shoes, so that we may determine whether a shoe belonged to a female or adolescent, since an adolescent may grow through the size range of a female. Men's shoes are easier to determine, since their feet grow the largest.

Through stylistic and size analysis, we can say that the overwhelming majority of modified shoes (81%) belonged to adult males.[190] In fact, of the shoes that showed evidence for modifications, 17 were worn attributed to adult men, 1 to a female or adolescent, 1 to a small child, and 2 to an unknown group.[191] That 81% of the modified shoes belong to adult men strongly suggests that they were the ones predominantly benefitting from shoe modifications.[192]

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[190] See Appendix B for all shoes and their possible owners. In the appendix the AGE/SEX category lists AM, Sm Ch, and F/Ad as possible owners. Here, AM represents adult male; Sm Ch stands for small child; F/Ad represents female or adolescent. Groenman-van Waateringe's 1978 paper set forth parameters for sex estimation based on foot size samples collected from six Roman or Medieval sites.

[191] See figure 4.6 for a visual representation of these numbers. Shoe sizes are based on information from Groenman-van Waateringe, 1978. In this publication, Groenman-van Waateringe notes that the curve of feet sizes belonging to children, women, and men, can overlap each other in places. To help determine the sex of the shoe wearer, therefore, multiple measurements should be considered. Relying on foot length alone can only provide so much information – foot widths may also reveal sex of the wearer. Changes in style over time can also sex the owner of a shoe. For a study that shows how width matters when sexing feet and shoes, see Wunderlich and Cavanagh 2001.

[192]Groenman-van Waateringe 1978 suggests that a typical Roman military site will have many more men than women and children. That more men populated military sites than women could factor into why men are more represented in the modified shoe ownership than women or children, though the gap is still entirely too large for this to be the only contributing cause of the disparity in representation.

There are multiple reasons why most modified shoes may have belonged to men. One reason is that soldiers were all men, and in a military settlement, they may have had better access to medical care. Included in this medical care could be people that could alter shoes. Another reason is that soldiers may have had greater knowledge concerning the benefits of modifying shoes than the general population. It is possible that the transmission of knowledge was mainly passed orally between military members. If this is the case, then it would explain why the largest share of modified shoes are attributed to adult men. Bearing in mind that the auxiliary units were non-citizen units, this means that knowledge of shoe modifications could have come from sources that were not culturally Roman.

The percentages of who owned the modified shoes stands in contrast to the breakdown of ownership throughout the assemblage. Of the 3,340 shoes that are preserved well enough to make a size determination, a total of 2,117 (63%) appear to have belonged to adult males, 737 shoes (22%) appear to have belonged to either a female or an adolescent male growing through the female size range, and 486 shoes (15%) belonged to children. Therefore, of the assemblage with demonstrable size and sex attribution, 63% were probably worn by adult males, a large percentage of which were likely to have been soldiers, while 37% appear to have been worn by non-male individuals, most of which were likely women, adolescents, and children (see figures 4.5 and 4.6 to view percentages of overall shoe ownership versus modified shoe ownership).

The data from the smaller case study used here, the Severan period defensive ditch dating to the early 3rd century, follows a similar pattern. Of the 423 shoes discovered in the 2016-17 excavation of the western ditch section, 55% were worn by adult males, 19% were worn by females or adolescents, 19% were worn by children, and 7% did not provide enough clear evidence for determination. The percentage of shoes belonging to female or adolescent individuals is strikingly similar to the percentage from the assemblage as a whole, suggesting that it represents a true pattern across the occupation of the fort and may remain somewhat consistent throughout the assemblage.

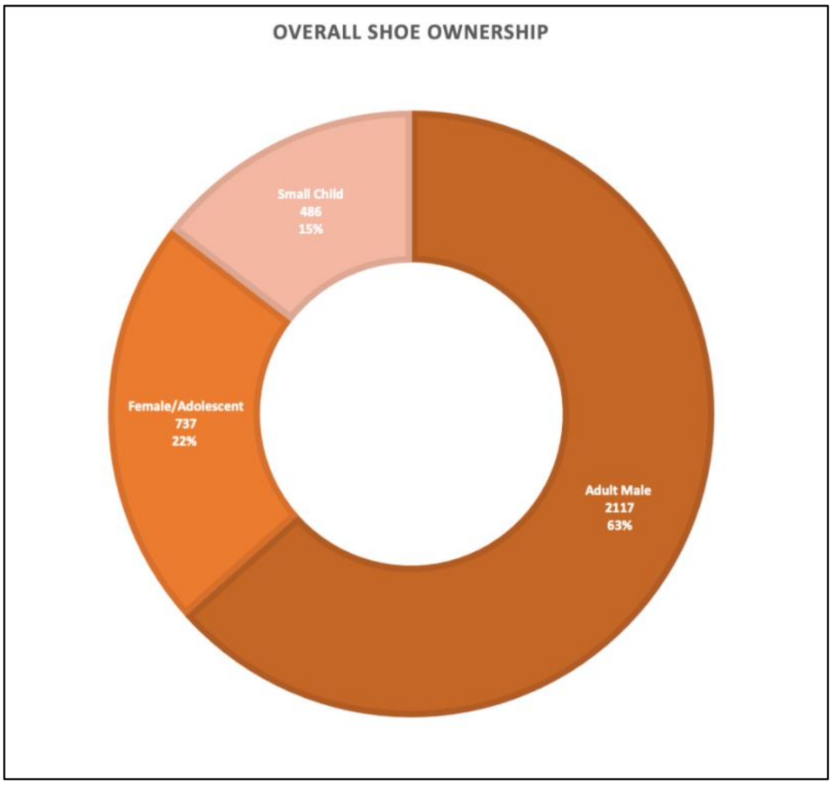

Figure 4.5: Overall shoe ownership encompassing shoes from the 1985-2017 excavations.

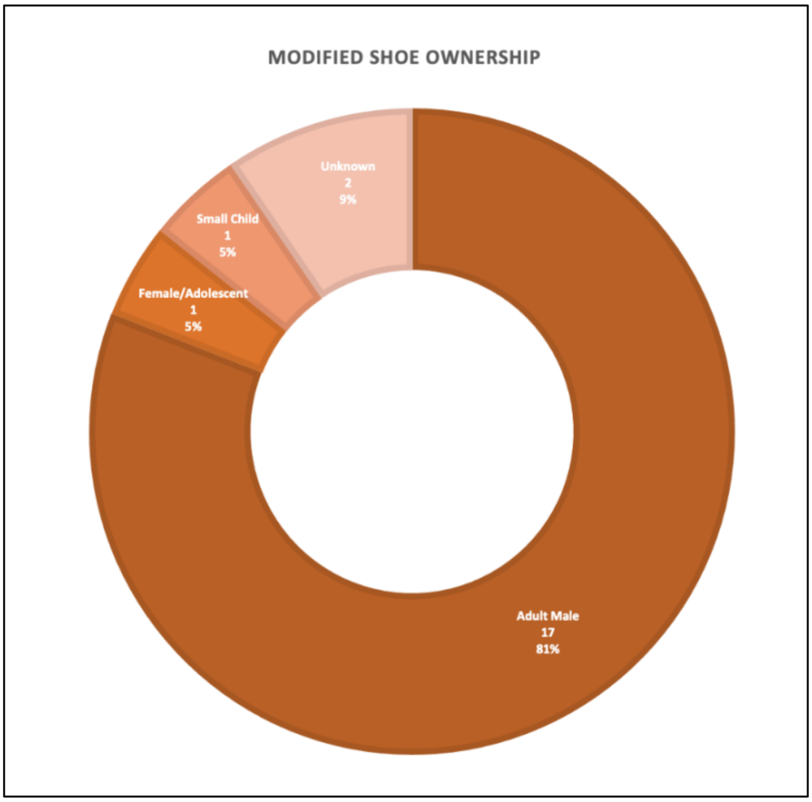

Figure 4.6: Attributed ownership of the modified shoes, including modified shoes from 1985-2017 excavations. Note that while 63% of the total assemblage of shoes is attributed to adult males, they account for 81% of the modified shoes.

Only one shoe, representing 5% of the modified shoes, belonged to a small child. One other shoe belongs to either a female or unsexed adolescent. Two modifications have unknown ownership because they were found detached from the shoe sole to which they belonged. Regardless of the ownership assigned to the final two examples of metal orthotics, the vast majority of modified shoes were worn by adult males. Given that children outgrow shoes at a fairly quick rate, perhaps it was deemed unnecessary to take time and resources to modify shoes. That line of thinking, however, falls short when considering that adult females presumably would have worn their shoes in similar ways as their male counterparts, yet are drastically underrepresented in the assemblage of modified shoes. Ultimately, the only statement that can be made about who had their shoes modified is that largely, it was an adult male activity. Very few females, adolescents, and children appear to have had their shoes modified to better suit them. The social status of those having their shoes modified cannot be determined, as the only available information about the owners' identity relates to the size of their shoes. Whether the shoes belonged to soldier, civilian, or merchant, footwear worn by adult males thoroughly dominated the assemblage of modified shoes.

4.4. A Diachronic View of Modification Practices

Investigation of the archaeological contexts and the occupation periods associated with each shoe reveals some interesting patterns in shifting practices of shoe modification. Of the seven metal orthotics, five were from Period 6, dating to ca. 140-160 CE (fig. 4.7). The earliest orthotic bar was from Period 3, 100-105 CE (fig. 4.8), and its design is less refined than the later iterations of the metal bar, suggesting that the bar from Period 3 may have been an early attempt at correcting gait issues. In later periods of occupation, the bar becomes thinner and fits between rows of hobnails (fig. 4.9). It can be difficult to determine whether the metal bars were added during original production of the shoe or whether they were added in post-production and were a later thought. If the former, then the shoe cobbler may have had some knowledge about shoe modifications, and if the latter, it could have been a form of 'do-it-yourself' work or were problems identified by the wearer and the modification was requested. All the identifiable metal bars were on shoes that have been identified as worn by an adult male.

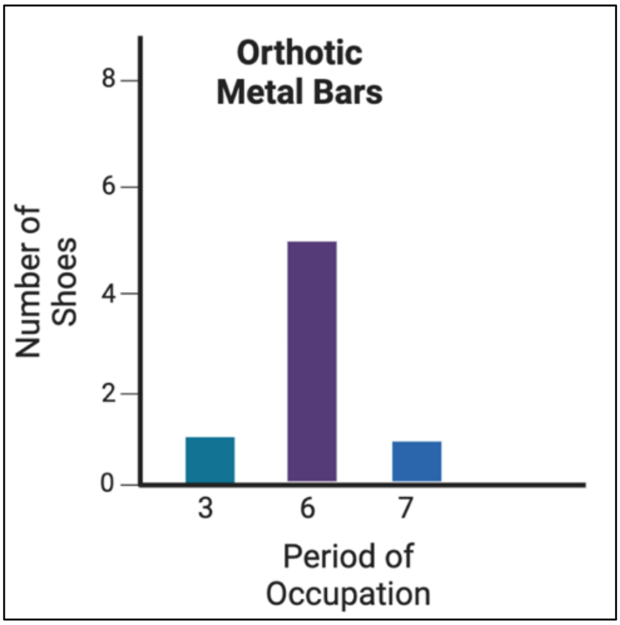

Figure 4.7: Prevalence of orthotic bars found in the Vindolanda assemblage, along with the period in which they belonged. Most of the shoes were from Periods 6 and 7, with the 1 shoe from Period 3 acting as an outlier. The bar from Period 3 is significantly thicker and less refined than the bars from the later dates.

Figures. 4.8 and 4.9: L-2001-69 features a much thicker, less refined, bar than L-1991-2800. The former bar was from an earlier phase of occupation than the latter (Period 3 versus Period 6). L-2001-69 courtesy and copyright of Dr. Elizabeth Greene and the Vindolanda Trust. L-1991-2800 copyright of Casey Boettinger and the Vindolanda Trust.

All four of the shoes that included a bronze disk on the insole belonged to adult males. These modifications were in use during Periods 1, 2, and 4 of the fort (from 85-

120 CE). Shoes with bronze disks on the insole all date before iron-studded insoles appear in the assemblage and were perhaps transitioned out after Period 4. A plausible reconstruction of shifting practice would see the bronze disks going out of use, and shortly after the iron studded insoles coming into use. This interpretation would suggest that medical practices within the military shifted through time and if we had large assemblages of footwear from elsewhere in the Roman empire, perhaps we would see similar shifts in knowledge and technology transfer.

Another way to interpret this chronological pattern is to consider who was present on site in the different occupation periods and what specific knowledge they may have carried with them into the military environment. Since Vindolanda was a military fort occupied by auxiliary units and their dependents, we often know something about the cultural background of those present. In Period 1, part of Period 2, and Period 4, the site was occupied by Tungrians, who were a unit raised from the Roman province of Gallia Belgica (northern Gaul), a region now located in modern day Belgium.[193] In part of Period 2 and Period 3, the Batavians, a group from the Roman province of Germania that is now around Amsterdam in the Netherlands, occupied the site.[194] We know a great deal about these units and when they were present at Vindolanda because of the information found in the writing tablets,[195] and other archaeological evidence suggests retention of habits that were Tungrian in origin, such as religious worship.[196] Both the Tungrians and Batavians are Germanic and hail from neighboring regions in

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[193] For full coverage of the Tungrian units in the Roman army and specifically at Vindolanda, see A. Birley 2002; Birley, Birley, Stempel 2013.
[194] Birley 2002.
[195] Bowman and Thomas 1994, 2003; Birley 2002.
[196] Birley, Birley, Stempel (2013) report on an inscription from the period IV ditch to the otherwise unknown goddess Ahvardua and attribute its origins to the area of northern Gaul whence the Tungrians hailed.

northwest Europe where some practices may have been shared. Since certain types of shoe modifications, such as the flat bronze discs on the insole, were used only in these first four periods, we might attribute this practice to the groups that were living on site at the time, though this cannot be proven with certainty.

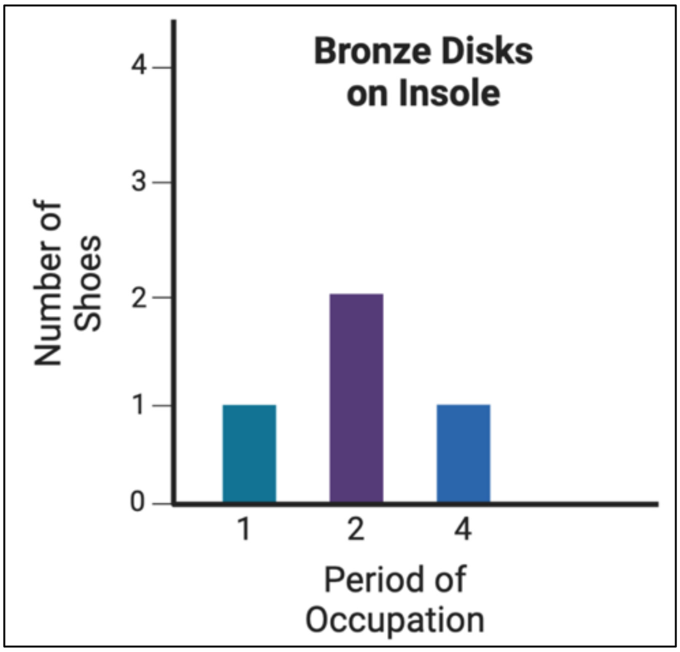

Figure 4.10: One shoe comes from Period 1, two shoes from Period 2, and one from Period 4.

The iron studded insoles show similar patterns and provide insight into the ages of those using the modification. Of the four shoes, one belongs to a small child and the other three to adult males. The child's shoe came from Period 6B (200-212 CE), while the three shoes belonging to adult males were less well contextualized and may have come from Periods 3, 4, or 5 (100-130 CE).[197] Though the small sample does not allow for robust analysis of diachronic shifts, perhaps this could be an example of how styles

[197] See the description for figure 3.9.

and information disseminate through different demographic categories over time: what at first was a modification that only adult men had access to, later became knowledge that could be accessed by others.

The occupational context was only definitive for two of the shoes above: the child's shoe from Period 6B and one of the adult male shoes from a context belonging to Period 4. Figure 4.11 shows that another two shoes, on top of the one shoe certain to belong to Period 4, could have belonged to an adult male from Period 4. In the case of the shoe labelled "unmarked pre-1973" the object was separated from its original site find number in the off-site conservation lab and lost its contextual information. In this case, however, an understanding of shoe styles through time plays a crucial role. Whilst the two shoes that lack clear contextual information cannot be attributed to Periods 3 or 4 with certainty, their style betrays their date to the early second century CE. The style of sandal soles such as the ones under consideration here shifted rather quickly and these all follow the style worn in Periods 3 and 4 at Vindolanda, indicating a similar date for manufacture and ownership.[198] These shoes suggest that adult males had first access to knowledge of specific shoe modifications. This knowledge may have disseminated throughout the community in later years, such that children were able to benefit from the modifications.

[198] van Driel-Murray 2007: 355-58.

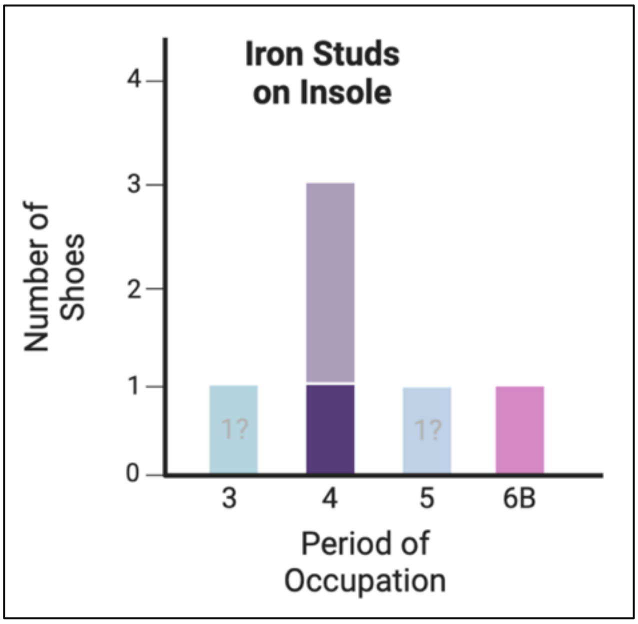

Fig. 4.11: This graph shows the uncertainty of usage date surrounding the iron studded insoles. One shoe from Period 4 and one from 6B have certain date attributions, while the other two shoes may have also been from Period 4 or the occupation phases just before or after.

4.5. Conclusion

The archaeologist's job is to make use of all the material evidence around them to hypothesise about past populations. The study of health in a population has often been the purview of the bioarchaeologist who is able to study bones for evidence of nutrition, disease, and age-at-death, and the discussion of ancient medicine is often relegated to scrutinizing textual sources. In the absence of bones, however, archaeologists may still use other material goods to infer what life was like so long ago. The shoes at Vindolanda provide such an opportunity to study the bodies of those living in the past without the actual skeletal remains. This thesis has demonstrated some of the questions that can be answered by a thorough analysis of shoe modifications, in combination with additional contextual information such as the period the shoes came from, the size of the shoe as a proxy for potential owner, and the auxiliary units that lived at the fort during specific phases of occupation.

This thesis has centered around the idea that ancient literary sources did not record shoe modification as a viable option for foot care, and that, nonetheless, this knowledge did exist.[199] At Vindolanda, at the very least, evidence exists in the form of five separate modification types. Regrettably, since organic artefacts do not often survive in the environmental conditions present at most Roman sites in the empire, there are no comparative settlements with the sheer number of shoes as that found at Vindolanda. Future studies about shoe modifications and foot health may look towards civilian populations at sites such as London, since their environmental conditions were similar to those at Vindolanda and preserve a good number of shoes.[200] Other future directions for this research could look to the areas of northwest Europe, North Africa and the Middle East where small assemblages of shoes have survived either in waterlogged or desiccated environments to look for similar evidence of foot care.[201]

Despite a lack of ancient comparative evidence, the aim of this thesis has been to demonstrate that podiatry and the concept of gait analysis existed in the Roman world, and in some cases rather advanced techniques were used, such as iron orthotic bars added to shoe soles. An analysis of the population at Vindolanda, taken together with the fact that over 80% of the modifications occurred on shoes worn by adult males, raises questions about who possessed knowledge about or had access to shoe modifications. Were military doctors, many with names of Greek origin, detailing

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[199] With the exception of Hippocrates' treatment for clubbed foot mentioned in chapter 2.

[200] The London shoes have not been fully published, but a conservative estimate would place the number of recovered shoes around 3,000.

[201] While shoes from Egypt have also been excavated, their composition is such that they do not make an ideal comparable assemblage. The shoes found in Egypt tend to be constructed from palm fibers rather than material such as leather.

methods of shoe modifications? Was this knowledge orally passed down from person to person? Was it knowledge that came from the home countries of these auxiliary soldiers?[202] Rather than writing with certainty that this was Roman knowledge, analyses of the case study material has instead brought up the idea that this knowledge was held by other people. The community at Vindolanda ought to be considered as a multicultural living space, occupied by various peoples. We can say with certainty that at Vindolanda there exist shoes with modifications, and that they were likely meant to create better walking conditions for people who otherwise struggled with discomfort or an unfavourable gait. Auxiliary soldiers and the community at Vindolanda were not immune to conditions that made walking painful. Some people overpronated when walking, some suffered the pain of bunions, and others sought treatment in the form of a massage-type modification.

It may be of interest, in the future, to study sites and written works from the places where the auxiliary soldiers came from. By doing so, perhaps the question "who had the knowledge needed to modify shoes?" may be answered more fully. Despite being hired as soldiers and working for the Roman empire, these people who populated Vindolanda had their own rich traditions, culture, and knowledge to draw from. It is quite possible that the auxiliary soldiers brought their own expertise to Vindolanda, altering shoes for the benefit of the person wearing them.

[202] Appendix C lists the auxiliary units at Vindolanda throughout its occupation as well as the modification types that were found during those periods.

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Appendix A

Shoes from the case study in chapters 3 and 4.

	Object Number	**Measurements (length or height x width or diameter)**	**Brief Description**	**Image**
Modification Type				
Orthotic Metal Bar	L-1991-2800	240mm x 87mm	Metal bar located snugly between two rows of studs. The attachment in the middle of the heel seems to go over a stud, suggesting the bar is a later addition to the shoe.	

Orthotic Metal Bar	L-1991-2894	215mm x 68mm Depth: 78mm Weight: 168g	The metal bar is located on the lateral side of the shoe. Metal bar appears to be over some studs, though it could have shifted over time from the surrounding pressure of the soils it was found in. If intentionally placed over studs, this suggest the bar was added in post-production. Perhaps a home remedy, something that the owner added in for themselves.	
Orthotic Metal Bar	L-1991-3170	Varied x varied	Metal plate with holes in which to fit studs. Based on the curvature of the plate, it would have been situated at the tread area. Of the two hobnail holes visible, one still has a piece of hobnail stuck in it.	

Orthotic Metal Bar	L-1992- 3745	265mm x 92mm Weight: 142g	The metal bar attached at the distal/proximal edge and at the middle of the heel. Bar would have extended right up to the waist of the sole.	
Orthotic Metal Bar	L-2001-69	270mm x 77mm Depth: 19mm Weight: 73g	Sole layers with a heel stiffener attached. Metal bar placed on the lateral edge of the heel. The bar is significantly thicker than the other excavated bars. It dates to earlier than the other metal bars, suggesting perhaps this was a prototype from which the other bars were created. The bar is not long, ending well before the waist begins.	

Orthotic Metal Bar	L-2005-67A	85mm x 55 mm Depth: 21mm Weight: 23g	Disarticulated scraps (not pictured) with a metal bar. Bar appears more 'c-shaped' than the others that remain attached to shoes. This bar is quite thin in appearance.	
Orthotic Metal Bar	L-2007-36A	250mm x 85mm Depth: 59mm Weight: 279g	Leather shoe with an iron bar along the heel of the tread sole. On the distal side, the bar is placed between rows of studs, but on the proximal side, the bar is on the outermost edge of the sole.	

Bronze Disks on Insole	L-2001-49	241mm x 76mm Depth: 14mm Weight: 82g	Bronze disk on the insole of the shoe on the proximal side. There is a clear impression where a second bronze disk used to sit on the distal side, just across from the other bronze disk.	
Bronze Disks on Insole	L-2002-217A	242mm x 78mm Depth: 23mm Weight: 156g	One visible bronze disk at the very back of the seat. There is also an impression left behind from what would have been another disk located at the lateral edge of the seat. The quality of the shoes is quite nice; the big toe and second toe have cut-out definition.	

Bronze Disks on Insole	L-2016-27	250mm x 100mm Depth: 18mm Weight: 125g	Two disks at the toe portion of the sole. One disk is located medially between tread and toe area. The other disk is located almost at the top of the toe but is a little more laterally placed.	
Bronze Disks on Insole	W-1987-398	233mm x 75.6mm Depth: 33mm Weight: 79g	Wooden bath clog with a bronze disk located in the middle of the seat. Decorated with 7 hobnails: 4 medial waist, 3 lateral waist. Unlike the other bronze disks, this one is not located right at the border of the shoe.	

Iron Studs on Insole	Unmarked pre-1973	N/A	There used to be eight studs on the insole, now only two remain. All eight were on the bottom half of the shoe, from the waist to the heel. The studs formed a perimeter around the heel area.	
Iron Studs on Insole	L-1988-2023	235mm x 73mm Depth: 19mm Weight: 171g	Five studs on the insole. Two are on the proximal side resting at the widest part of the sole. The other three studs are grouped together on the distal side of the shoe, just below the widest point. There is a hole where one more stud likely sat with the group of three.	

Iron Studs on Insole	L-1994-4242	250mm x 86mm Weight: 273g	Stud located on the proximal side of the shoe at the waist. The stud would have met with the arch of the foot with each step taken.	
Iron Studs on Insole	L-2016-163	165mm x 55mm Depth: 33mm Weight: 68g	Stud appears to be nailed in from the insole layer or just below. The stud sits at the waist on the proximal side of the shoe.	

Extra hobnails	L-2016-153	194mm x 60mm Depth: 17mm Weight: 69mm	Grouping of nails both at the tip of the toe and on the proximal edge of the heel.	
Extra hobnails	L-2016-159	250mm x 88mm Depth: 40mm Weight: 89g	Sole in poor condition, but a grouping of hobnails remains visible at the proximal side of the heel. Grouped together for added support on the inside of the heel.	

Extra hobnails	L-2016-191	235mm x 70mm Depth: 21mm Weight: 95g	Hobnails appear relatively evenly spaced across the entirety of the sole, except for a grouping of them at the tip of the sole. The heel of the sole appears to have had a diamond-type design created by the placement of hobnails.	
Extra hobnails	L-2016-334	260mm x 95mm Depth: 77mm Weight: 158g	Hobnails appear to have been first evenly spaced throughout the sole. In the lower half (from the waist to the heel), additional hobnails disrupt the flow of the design. Most especially, hobnails on the proximal side of the heel area change the original design of the nails. Additionally, there appears to be a concentration of hobnails at the tip of the shoe.	

Extra hobnails	L-2017-52	222mm x 74mm Depth: 40mm Weight: 90g	There is a concentration of hobnails on the proximal side, near where the big toe would be placed in the shoe. The uniform spacing of the other hobnails reveal the oddity.	
Additional Leather	L-1994-4242	250mm x 86mm Weight: 273g	This shoe has four extraordinarily thick sole layers. The shoe is quite heavy, owing to the sheer thickness of the sole layers. Most soles are between 3-5mm, these are much larger, though no exact measurement has yet been taken.	

Additional Leather	L-2002-257A	248mm x 85mm Depth: 18mm Weight: 154mm	The tread sticks out quite a lot on the lateral edge, where the additional leather piece is located. Protrusion plus additional leather suggests the owner had their shoe created to support their tread area when walking. The added leather is only visible because part of the insole is missing.	
Additional Leather	L-2016-27	250mm x 100mm Depth: 18mm Weight: 125g	Extra leather under the big toe area. Attached to the final sole layer, midsoles stack on top. Provided extra padding for the individual wearing the shoe.	

Appendix B

Excel sheet detailing the shoes from the Vindolanda assemblage. Information collected from personal study, Dr. Elizabeth Greene, and the VALP database.

Type of Modification	Context	Spatial	Period	Date Range	Construction	Type	Size (mm)	L/R Shoe	Side of	AGE/SEX
Orthotic Metal Bar										
L-1991-2800	B1 VI Ditch	Ditch	6	140-160	Nailed	Unknown	240	R	Lateral	AM
L-1991-2894	B(N) VI Ditch	Ditch	6	140-160	Nail+Thong	Low shoe	215	R	Medial	AM
L-1991-3170	C1 VI	?	6	140-160	Metal Plate	Unknown	0	Unknown	Unknown	N/A
L-1992-3745	G(N) VI	Laminate	6	140-160	Nailed	Unknown	265	R	Lateral	AM
L-2001-69	V-2001-19A	Laminate flooring	3	100-105	Nail+Thong	Unknown	270	R	Lateral	AM
L-2005-67A	V2005-25A	Berm (m.m.hill)	7	213-275	Nailed	Unknown	0	Unknown	Unknown	N/A
L-2007-36A	V2007-68A	Ditch	6	140-160	Nail+Thong	Low shoe	250	L	Entire seat	AM
Bronze Disks on Insole										
L-2001-49	V2001-18A	Ditch	1	85-90	Nail+Sew	Sandal	241	L	(2)Both sides, top of seat	AM
L-2002-217A	V-2002-36A	Schola	4	105-120	Other	Sandal	242	R	(1) Middle of heel, (1) lateral heel)	AM
L-2016-27	V2016-53B	Laminate flooring	2	90-97	Nailed	Unknown	250	L	(2)Medial, by big toe	AM
W-1987-398	LXXIII II. G	?	2	90-97	Clog	Clog	233	R	(1)Middle of heel	AM
Iron Studs on Insole										
L-1988-2023	LXXIII XVII IV/V	?	4 or 5	105-130	Nailed	Sandal	235	R	3 lat, 2 medial,	AM
L-1994-4242	LXXIV (NE) IV	?	4	105-120	Other	Sandal	250	R	Medial waist	AM
L-2016-163	V2016-68B	Ditch	6B	200-212	Nail+Thong	Unknown	166	R	Medial waist	Sm Ch
unmarked pre-1973	No context	None	P.3-4 shape	100-118	Thong	Sandal	245	L	Around heel - waist	AM
Additional Hobnails on Tread Sole										
L-2016-153	V2016-68B	Ditch	6B	200-212	Nail+Thong	Unknown	194	R	Tip of toe, medial heel	F/Ad
L-2016-159	V2016-68B	Ditch	6B	200-212	Nail+Thong	Unknown	250	R	Medial side of heel	AM
L-2016-191	V2016-68B	Ditch	6B	200-212	Nail	Unknown	235	L	Tip of toe	AM
L-2016-334	V2016-81B	Ditch silt (top)	6B	200-212	Nail+Thong	Boot	260	R	Medial side of heel	AM
L-2017-52	V2017-5B	Ditch	6B	200-212	Nail+Thong	Unknown	222	L	Medial, toe	AM
Additional Leather										
L-2002-257A	V2002-42A	Ditch	6A	160-200	Nail+Sew	Sandal	248	R	Lateral, seat	AM
L-2016-27	V2016-53B	Laminate flooring	2	90-97	Nailed		250	L	Thick midsole layers	AM
L-1994-4242	LXXIV (NE) IV	?	4	105-120	Other	Sandal	250	R	Medial by big toe	AM

Appendix C

The garrisons that populated Vindolanda during specific periods of occupation and the modifications that were found in each phase of occupation.

Period of Occupation	**Dates**	**Garrison**	**Types of Modifications**
1	c. AD 85-90	I Tungrorum	Bronze disk on insole
2	AD 90-100	I Tungrorum, IX Batavorum	Bronze disk on insole, Additional leather
3	AD 100-105	IX Batavorum	Orthotic metal bar, Irons studs on insole
4	AD 105-118	I Tungrorum, Vardulli cavalry	Bronze disk on insole, Iron studs on insole, Additional leather
5	AD 120-130	I Tungrorum	Iron studs on insole
6	c. AD 140-160	II Nerviorum	Orthotic metal bars
6A	c. AD 160-200	Unknown	Additional leather
6B	c. AD 200-212	Unknown	Additional hobnails on tread sole
7	c. AD 213-275	IV Gallorum	Orthotic metal bar
8	c. AD 300-367	IV Gallorum	X
8A	c. AD 367-408	Unknown	X
9A	c. AD 409-600	Brigomaglos Warband	X
9B	c. AD 600-800	Population Unknown	X
10	AD 800+	Population Unknown	X

Curriculum Vitae

Name: Casey Elizabeth Kay Boettinger

Post-secondary Education:

Western University
London, Ontario, Canada
2016-2020 B.A.

Western University
London, Ontario, Canada
2021-2023 M.A.

Honours and Awards:

Social Science and Humanities Research Council Canada, Graduate Scholarship Master's (SSHRC CGS M)
2022

Ontario Graduate Scholarship (OGS)
2021

Faculty of Arts and Humanities Chair's Entrance Scholarship
2021

Ivey Foundation Continuing Awards in the Arts
2016-2020

Wilfred and Zeta O'Donnell Travelling Fellowship
2018

Faculty of Arts Alumni Awards
2018

International Learning Award
2017

Global Opportunities Award
2017

Western Scholarship of Excellence
2016

Arts and Humanities Entrance Scholarship
2016

Related Work Experience:

Conference poster:
"Fancy Footwork: Podiatric Knowledge on the Roman Frontier"
|2023, Archaeological Institute of America

Conference poster:
"Following Their Footsteps: Tracing the Lives of Children in Romano-British Military Forts"
2022, Classical Association of Canada Conference

Teaching Assistant

Western University 2021-2023

Research Assistant

Western University 2021-2023