Health and demography in late 19th century Kimberley : a palaeopathological assessment

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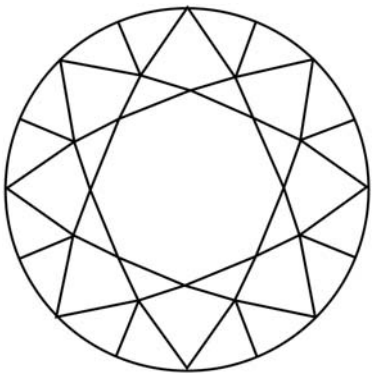

CHAPTER 4

Trauma and Amputations in 19th Century Miners from Kimberley, South Africa

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Trauma and amputations in 19th century miners from Kimberley, South Africa

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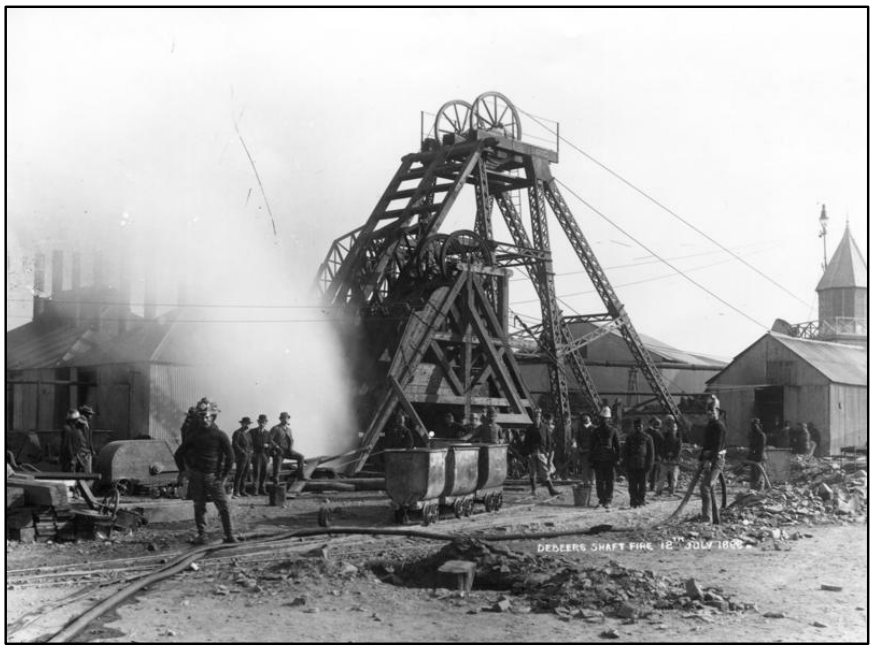
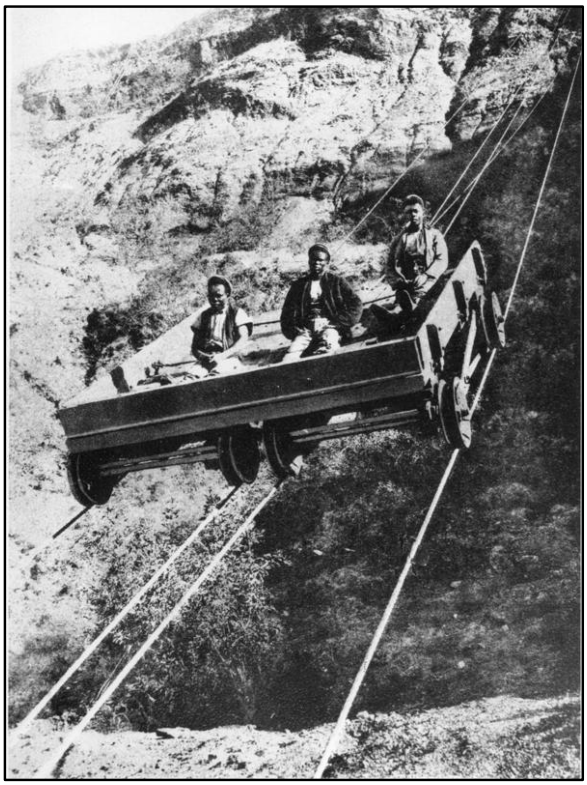


De Beers Mine disaster, 12 July 1888
(McGregor Museum Kimberley photography nr.2459)



Kimberley mine aerial gear, 1890s
(McGregor Museum Kimberley photography nr.5030)

Abstract

Trauma is the result of violent, accidental or therapeutic events that cause physical or psychological injury. The frequencies and types of trauma within a population can give important information regarding lifestyle as well as the quantity and quality of medical care available to them. The purpose of this study was to assess the prevalence of trauma in the Gladstone sample population with regards to the presence of interpersonal violence, a hazardous working environment, strenuous working requirements and the availability of medical care.

The individuals studied here were diamond miners from Kimberley, dating to the late 19th century. A total of 107 well-preserved skeletons were excavated from unmarked graves after accidental discovery. This sample included 86 males, 15 females and 6 individuals of unknown sex. The majority of individuals (72%) were between 20 and 49 years of age. The remains were most likely those of migrant mine workers of low socioeconomic status who had passed away in local hospitals. All bones were visually assessed for macroscopic indications of traumatic bone alterations and compared to standard palaeopathological texts and photographs.

A total of 26.2% (n=28) of the individuals in the sample presented with well-healed, healing or perimortem fractures. Fractures to the skull encompassed 48.8% (n=20) of all fractures observed. A total of six (5.6%) amputations were noted. Spondylolysis was observed in 8.5% (n=7) of individuals within the sample and longstanding subluxation was noted in two persons. The high prevalence of cranial fractures within this population is suggestive of high levels of interpersonal violence, while long bone fractures, spondylolysis and evidence of longstanding subluxations are most likely testament to the strenuous work requirements and the high-risk environment to which these individuals were exposed on a daily basis. When considering the presence of well-reduced fractures and healed amputations, it seems that adequate medical care was available to at least some members of this community.

4.1 Introduction

Diamonds were first discovered on Colesberg Kopje (today known as the 'big hole') in Kimberley, South Africa in 1871. By August of that year, approximately 800 claims had been cut out of Colesberg Kopje and between 2000 and 3000 men were working there (Roberts, 1976). Colesberg Kopje was soon to become Kimberley, the first town in South Africa to be completely dependant on its mineral wealth, the first to experience a strike and the first town to have its streets lit by electricity (Roberts, 1976).

During the late 19th century, historical documents indicate that 'native' individuals flooded to Kimberley from surrounding areas and neighbouring countries in search of work in the mines (Stoney, 1900). A census held in 1898 established there were approximately 14 500 Europeans and 26 500 black labourers living and working in Kimberley (Stoney, 1900). The number of black labourers in Kimberley was extremely changeable and dependant on the demand for labour in the mines (Stoney, 1900; McNish, 1970; Jochelson, 2001). Black labourers ''from almost every tribe south of the Zambezi'' (Roberts, 1976:15) were brought to Kimberley to work and when their contracts expired, returned to their 'kraals' (Leary, 1891; McNish, 1970; Roberts, 1976:294).

Mining was a labour-intensive task, fresh fruit and vegetables were scarce, comfortable accommodation was restricted and medical care limited. All of these factors contributed to the high prevalence of disease and injury described in archival documents reporting conditions treated at the Kimberley Hospital (Cape of Good Hope Votes and Proceedings of Parliament (CGHVPP), 1899; Stoney, 1900; Roberts, 1976; Van der Merwe, 2007).

Labourers received medical attention from the Kimberley and Compound Hospitals. In the case of death, the patient was wrapped in blankets and received a pauper's burial, without a coffin, in the Gladstone or other surrounding cemeteries (Swanepoel, 2003).

The Gladstone cemetery was officially opened on 24 March 1883, and half of the ground was devoted to African burials. Nearly 5000 African individuals were buried at the Gladstone cemetery between 24 June 1887 and 28 November 1892. Unfortunately, no registers were available for the period between 1892 and 1900. However, some documents indicate that a total of 611 pauper burials took place between February and June 1900 (Swanepoel, 2003).

In 1897, Gladstone cemetery was enlarged with an extra strip of land, given by the De Beers mining company, on the eastern side of the cemetery (see Figure 4.1). The cemetery

was closed in mid-1900 and opened again in April 1902 for European internments only. In 2003, the Sol Plaatjie municipality uncovered several unmarked graves in the abovementioned eastern area with these remains becoming the focus of this research in which the traumatic injuries of diamond mine workers were assessed.

Trauma is the result of intentional or accidental encounters with animals, humans and cultural hazards found in and around the home and working place, or therapeutic procedures that cause injury to a person (Merbs, 1989; Lovell, 1997; Walker, 2001; Neri & Lancellotti, 2004). The assessment of the prevalence of trauma in an archaeological population is difficult to interpret, since the investigation of dry bone poses several limitations. Determining trauma frequency rates is often hindered by poor preservation and fragmentation of skeletal remains and perimortem trauma often mimics post-depositional damage and consequently passes undetected. This is also the case in well-remodelled fractures (Grauer & Roberts, 1996).

Notwithstanding the difficulties, the assessment of trauma within a population can still yield considerable information. The prevalence and location of traumatic lesions are influenced by intrinsic factors such as age and sex, as well as extrinsic factors relating to culture (Lovell, 1997; Glencross & Stuart-Macadam, 2000; Ortner, 2003). Different environmental conditions and cultural practices expose individuals to specific traumatic hazards. Therefore, the study of the prevalence of trauma within a population can aid in reconstructing the occupational and environmental stresses the sample was exposed to, as well as various aspects of cultural behaviour

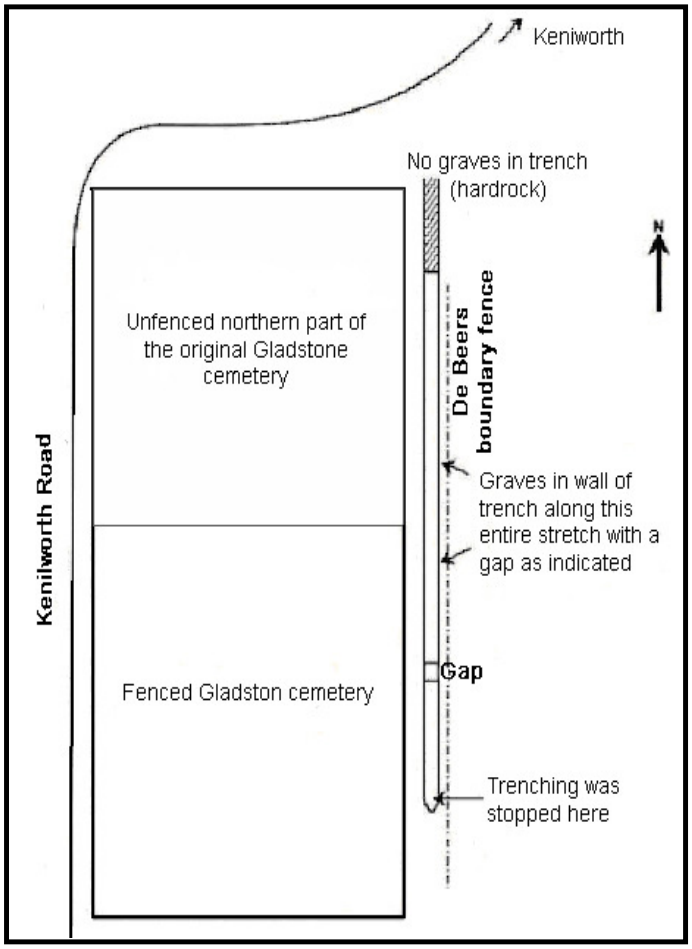


Figure 4.1 Map indicating the current fenced Gladstone cemetery, the location of the trench that uncovered the graves and the De Beers boundary fence. (Trench length ca. 180m)

(Steinbock, 1976; Jurmain & Bellifemine, 1997; Kilgore *et al*., 1997; Lovell, 1997; Ortner, 2003). By determining whether the fracture is healed, unhealed, reduced or infected, conclusions can be made regarding the availability of medical care and the accommodation of injured individuals within the community (Steinbock, 1976; Kilgore *et al*., 1997; Neri & Lancellotti, 2004).

The purpose of this study was to assess the prevalence of trauma in the skeletal population exhumed from the Gladstone cemetery. The prevalence, nature and location of fractures, amputations and longstanding subluxations will be interpreted and discussed with regard to the availability of medical care at the close of the 19th century, levels of interpersonal violence and exposure to a hazardous working environment (i.e. mining).

4.2 Materials and Methods

In April 2003, numerous unmarked graves were disturbed outside the fenced Gladstone cemetery. The McGregor Museum in Kimberley was given permission by the South African Heritage Resources Agency (SAHRA) to exhume and investigate the human remains.

The remains are believed to be those of migrant mine workers who died in surrounding hospitals in Kimberley between 1897 and 1900 (Van der Merwe, 2007). These individuals were most likely of low socio-economic status, malnourished and exposed to a high pathogen load (Van der Merwe, 2007). The low socioeconomic status of these individuals was clearly illustrated by their burial positions, with the majority of persons being laid to rest without coffins in graves containing more than one individual.

Standard anthropometric techniques such as morphological changes of the sternal ends of the ribs, changes to the pubic symphysis, cranial suture closure, as well as cranial and pelvic morphology and discriminant functions were used to determine the age and sex of all individuals exhumed from the trench (e.g. De Villiers, 1968; Krogman & Íşcan, 1986; Hillson, 1998; Oettlé & Steyn, 2000; Asala, 2001; Franklin *et al*., 2005).

A total of 86 males, 15 females and 6 individuals of unknown sex were excavated from the trench. The majority of these individuals (72%) were between 20 and 49 years of age, while the rest were comprised of one premature baby, two infants (both younger than one year of age), 13 juveniles (11–19 years) and four individuals older than 50 years of age. Due to the fragmentary condition of some of the remains, eight individuals could only be

described as adult and two were of unknown age. With the exception of these 10 skeletons, all others were remarkably well preserved and complete.

All bones were visually assessed for macroscopic indications of traumatic bone alterations and diagnoses were made based on the bony characteristics of the defects. All lesions were compared to standard palaeopathological texts and photographs as can be found in Steinbock (1976), Mann and Murphy (1990), Roberts and Manchester (1995), Larsen (1997), Aufderheide and Rodríguez-Martín (1998) and Ortner (2003). X-rays were not part of the routine investigation due to time and financial constraints.

Special attention was also given to distinguish between perimortem trauma and damage caused to the remains by the trenching machinery. Perimortem fractures were identified by the absence of signs of healing. Fracture lines associated with these fractures are generally sharp and coupled with radiating lines (hairline fractures) at the site of trauma. The fractured ends are also just as discoloured and weathered as the adjacent bone, and therefore it could be determined whether unhealed fractures were the result of damage by the trenching machinery or perimortem trauma (Steinbock 1976; Mann & Murphy, 1990; Roberts & Manchester, 1995; Ortner, 2003).

The prevalence of skeletal lesions indicative of trauma was determined in relation to the number of individuals within the sample population, as well as the number of bony elements investigated. These frequencies were compared to other studies conducted in South Africa and northern Chile (Eisenstein, 1978; Standen & Arriaza, 2000). Chi-squared tests were carried out in order to compare the prevalence of traumatic lesions between these comparative groups and the Gladstone sample. Where possible, chi-squared tests were also performed in order to test for significant differences in the frequency of lesions between males and females.

4.3 Results

4.3.1 Fractures

A total of 26.2% (n=28) of the individuals excavated from the trench (see Table 4.1) presented with well-healed, healing or perimortem fractures. Twenty-four of these were male and four female. No significant difference could be found in the frequency of fractures between the sexes (χ^2=0.006, p-value > 0.2).

Table 4.1 Number of individuals with fractures in the Gladstone skeletal sample.

Sex	n	nf	%
Males	86	24	27,9
Females	15	4	26,7
Total	107	28	26.2

n = number of individuals examined
nf = number of individuals who presented with one or more fractures

A total of 36 fractured bones were observed (see Table 4.2). These included 15 fractured crania, five fractured femora, four fractured ribs, two fractured fibulae, radii, ulnae and claviculae as well as one fractured tibia, os coxa, humerus and vertebra. It is clear that the majority of fractures occurred on the skulls, with 17.9% of crania presenting with (a) lesion(s).

Single fractures were noted in 19 individuals, while six people had two fractures, two had three fractures each, and one male had a total of four fractures. A summary of this information can be seen in Table 4.3.

Eight perimortem fractures were observed in five skeletons. Several well-healed and remodeled fractures were also noted. These included a parry fracture (see Figure 4.2), also known as a defense fracture as it is usually the consequence of a blow to the ulna when lifting the arm in a defense position (Mann & Murphy, 1990; Smith, 1996). A radial fracture (see Figure 4.3) and a Pott's fracture, which is a fracture of the distal fibula resulting from twisting of the ankle, (see Figure 4.4) were also noted. A sprinter's fracture was recorded in a male between 15 and 18 years of age (see Figure 4.5). This is an avulsion fracture of the anterior inferior iliac spine caused by sudden strain on the rectus femoris muscle (Merbs, 1989).

Table 4.2 Number of skeletal elements fractured in the Gladstone skeletal sample.

Sex	S	Fe	Ti	Fi	Oc	Ra	Ul	Hu	Cl	Ri	Vb	Total
n	84	181	173	166	161	164	164	169	159	**	**	
Males	12	4	1	2	1	2	2	1	1	4	1	31
Females	3	1	0	0	0	0	0	0	1	0	0	5
Total	15	5	1	2	1	2	2	1	2	4	1	36
%	17,9	2,8	0,6	1,2	0,6	1,2	1,2	0,6	1,3	**	**	

n = Number of skeletal elements investigated
** = Due to the fragmentary condition of ribs and vertebrae, the total number of elements could not determined.
S = skull; Fe = femur; Ti = tibia; Fi = fibula; Oc = os coxa; Ra = radius; Ul = ulna; Hu = humerus; Cl = clavicle; Ri = rib; Vb = vertebra.

Figure 4.2 A well-healed parry/defense fracture (arrow) of the right ulna observed in a 30–40 year old male (GLD N74.4).

Figure 4.3 A well-healed radial fracture (arrow) of the left radius observed in a 30–40 year old male (GLD N38.3).

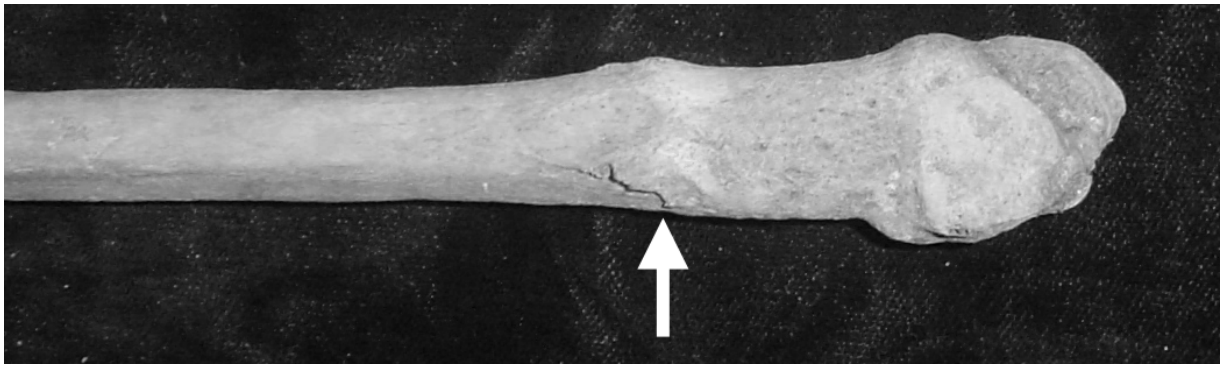


Figure 4.4 A well-healed Pott's fracture (arrow) of the right fibula observed in a 30–35 year old male (GLD N38.3).

Table 4.3 Prevalence of fractures observed in females from the Gladstone sample.

Number	Sex	Age (years)	Fr*	S	Fe	Ti	Fi	Oc	Ra	Ul	Hu	Cl	Ri	Vb
GLD SE11.6	F	30-37	1		1									
GLD N74.1	F	40-50	1	1										
GLD S2.4	F	33-43	2	1								1		
GLD SE7.5	F	30-43	1	1										
Total number of fractures in females			5	3	1							1		

Fr*=The number of fractures observed per individual. S = Skull; Fe = femur; Ti = tibia; Fi = fibula; Oc= Os coxa; Ra = radius; Ul = Ulna; Hu = humerus; Cl = clavicle; Ri = rib; Vb = vertebra.

Table 4.3 (cont.) Prevalence of fractures observed in males from the Gladstone sample.

Number	Sex	Age (years)	Fr*	S	Fe	Ti	Fi	Oc	Ra	Ul	Hu	Cl	Ri	Vb
GLD N31.E.1	M	30-40	3	3										
GLD N74.2	M	18-21	1	1										
GLD N74.5	M	40-55	1								1			
GLD N100.2	M	28-38	1									1		
GLD S1.2	M	25-35	1	1										
GLD N100.1	M	40-55	1	1										
GLD N34.3	M	30-35	2	2										
GLD N34.5	M	15-18	1					1						
GLD N34.6	M	22-28	1	1										
GLD N34.9	M	22-30	1	1										
GLD N34.12	M	22-30	1	1										
GLD N38.1	M	23-30	1										1	
GLD N38.2	M	25-29	4	1	1	1	1							
GLD N38.3	M	30-40	2				1		1					
GLD N74.6	M	30-45	3	2									1	
GLD N74.4	M	30-40	1							1				
GLD N8.2	M	25-30	1											1
GLD N8.10	M	20-25	1	1										
GLD S2.3	M	20-25	2		1				1					
GLD S2.9	M	35-45	2		1								1	
GLD S3.2	M	30-40	1										1	
GLD S3.5	M	25-30	1		1									
GLD S5.1	M	28-34	2	2										
GLD SE7.9	M	35-45	1							1				
Total number of fractures in males			36	17	4	1	2	1	2	2	1	1	4	1
Total number of fractures in sample			41	20	5	1	2	1	2	2	1	2	4	1

M = male; Fr*=The number of fractures observed per individual; S = Skull; Fe = femur; Ti = tibia; Fi = fibula; Oc = Os coxa; Ra = radius; Ul = Ulna; Hu = humerus; Cl = clavicle; Ri = rib; Vb = vertebra.

Figure 4.5 A healed sprinter's fracture of the anterior inferior iliac spine observed in a 15–18 year old male (GLD N34.5).

Fractures of the skull comprised 48.8% (n=20) of observed traumatic injuries and were by far the most frequent in the sample. These included six healed fractures of the nasal bone, one of the orbital margin, four fractures of the zygomatic bone, four depressed fractures of the frontal bone (see Figures 4.6 and 4.7) and five of the parietal bone. These lesions were all of relatively similar size and shape, with preference in location towards the left side of the skull. They are suggestive of blunt force trauma.

The limbs were the second-most affected body part, primarily with femoral fractures (n=5, 3%). Only one (1%) tibial and two (1%) fibular fractures were observed. The upper limbs were less affected than the lower limbs with the humerus (n=1, 1%), radius (n=2, 1%) and ulna (n=2, 1%) demonstrating five fractures in total (1% of investigated bones). No significant difference was observed between fractured bones of the upper or lower limbs (χ^2=0.502, p-value > 0.2). Furthermore, four rib fractures, two fractured clavicles and one vertebral fracture were also observed.

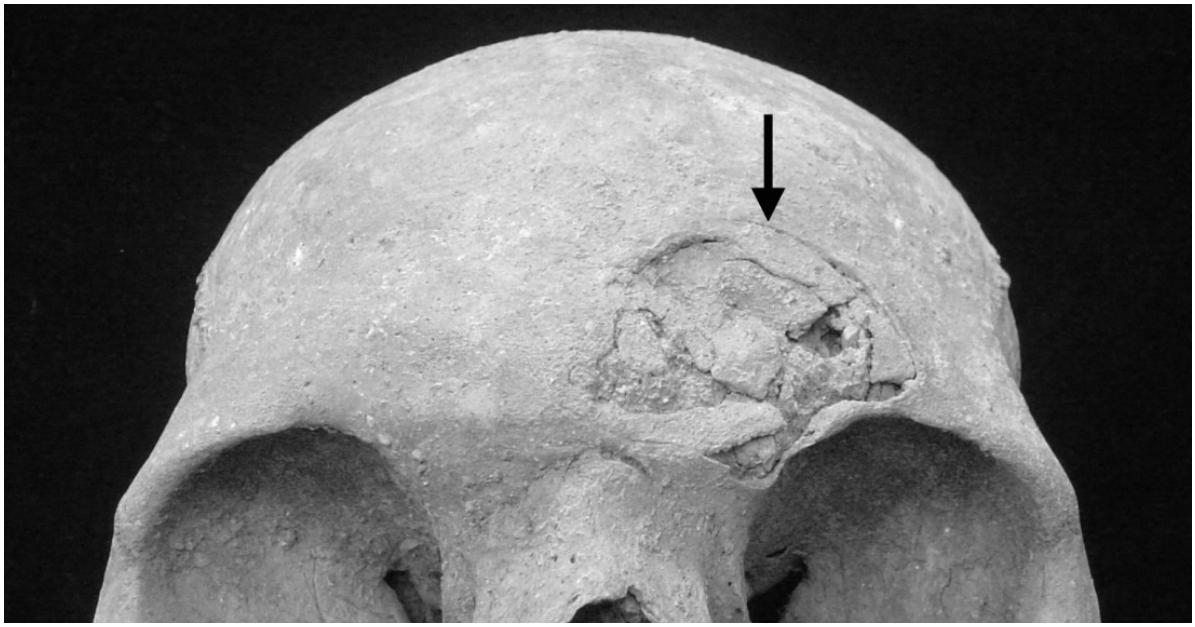


Figure 4.6 A partially healed fracture in the frontal bone in a 25–29 year old male (GLD N38.2).

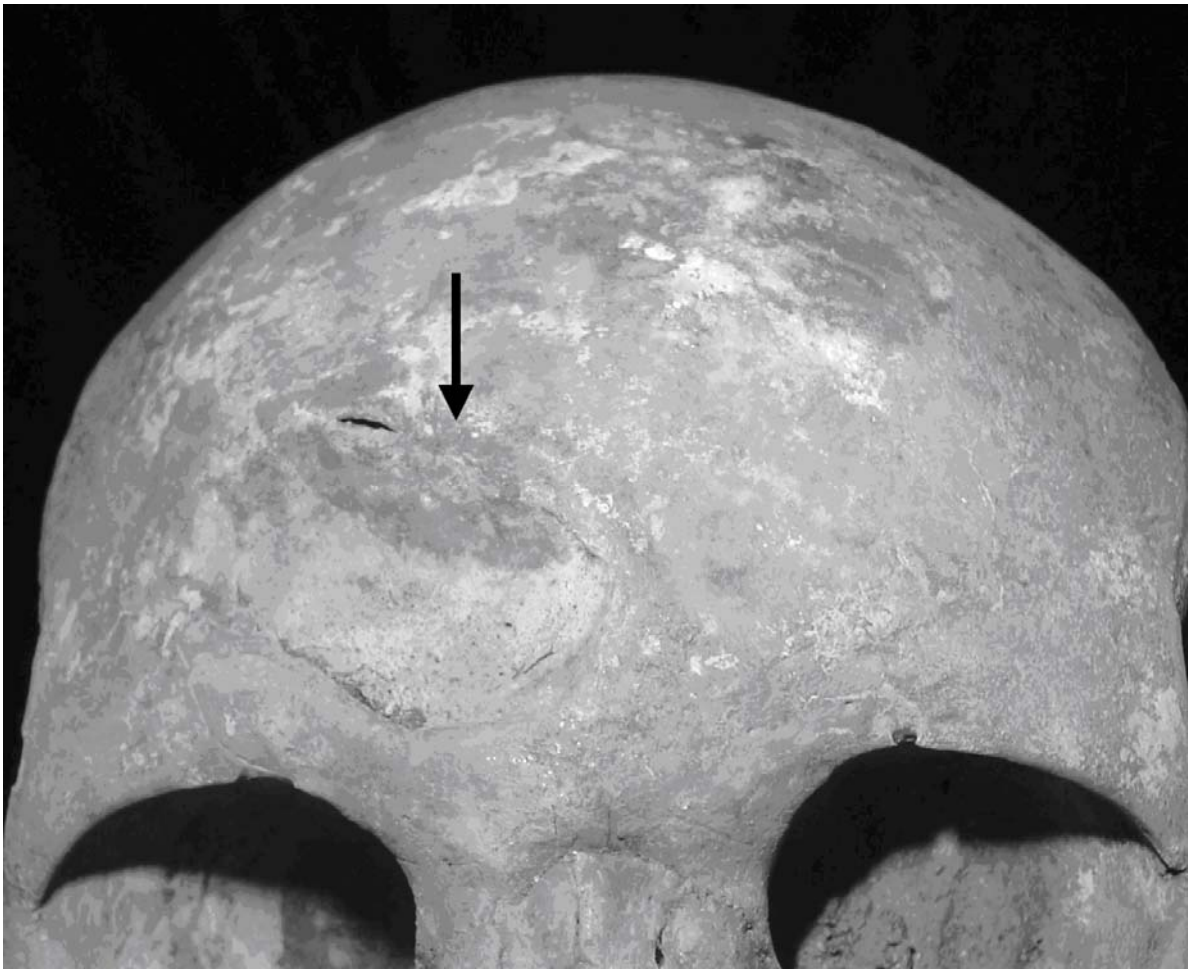


Figure 4.7 Healed depressed fracture of the frontal bone noted in a 30–40 year old male (GLD N31.E.1).

4.3.2 Spondylolysis and subluxation

Spondylolysis, a fracture of the vertebral arch resulting in bilateral separation of the pars interarticularis, was observed in 8.5% (n=7) of the sample (see Table 4.4). There was no significant difference in the prevalence of this lesion between the sexes (χ^2=0.001, pvalue > 0.2). All of the lesions showed bilateral separation of the neural arch (see Figure 4.8) and occurred on vertebrae L4 (n=3) or L5 (n=4). Spondylolysis associated with spondylolisthesis, the anterior sliding of the vertebral body as a result of the spondylolysis, was seen in one individual (GLD NOP 3/4.1). These injuries are often associated with strenuous physical labour and therefore can be expected to be present in these diamond mining labourers.

Another injury indicative of heavy, repetitive labour with little medical intervention would be the longstanding subluxation of joints, which was noted in two individuals (see Table 4.4). The first was in the right sternoclavicular joint of individual GLD S2.6,

Figure 4.8 Bilateral spondylolysis of L5 in a 35–50 year old male (GLD N 74.7).

resulting in remodelling and the formation of an articulation facet on the inferior surface of the sternal end of the clavicle. The second was found in a 40–55 year old male (GLD N74.5), with a fracture of the left humerus as the most likely cause. The non-reduced fracture caused shortening of the humeral shaft as well as medial rotation of the distal end of the humerus. In order to attain some functionality of the arm, subluxation of the shoulder joint occurred (see Figure 4.9). The subluxation caused a false articulation facet to develop between the acromion and the posterior surface of the humeral head. This most probably led to an unstable shoulder joint, with the humerus in a position of hyperextension and lateral rotation.

Table4.4 Prevalence of spondylolysis and subluxation in the Gladstone population.

Number	Sex	Age (years)	Spondylolysis	Spondylolisthesis	Subluxation
GLD N31.E.1	M	30-40	1		
GLD N74.3	M	17-22	1		
GLD N74.8	M	16-20	1		
GLD N74.5	M	40-55	1		1
GLD N34.8	F	20-23	1		
GLD N74.7	M	35-50	1		
GLD NOP 3/4.1	M	25-35	1	1	
GLD S2.6	M	35-45			1
Total			7	1	2
n			82	82	107
%			8.5	1.2	1.8

n - total number of individuals investigated, M – male, F – female.

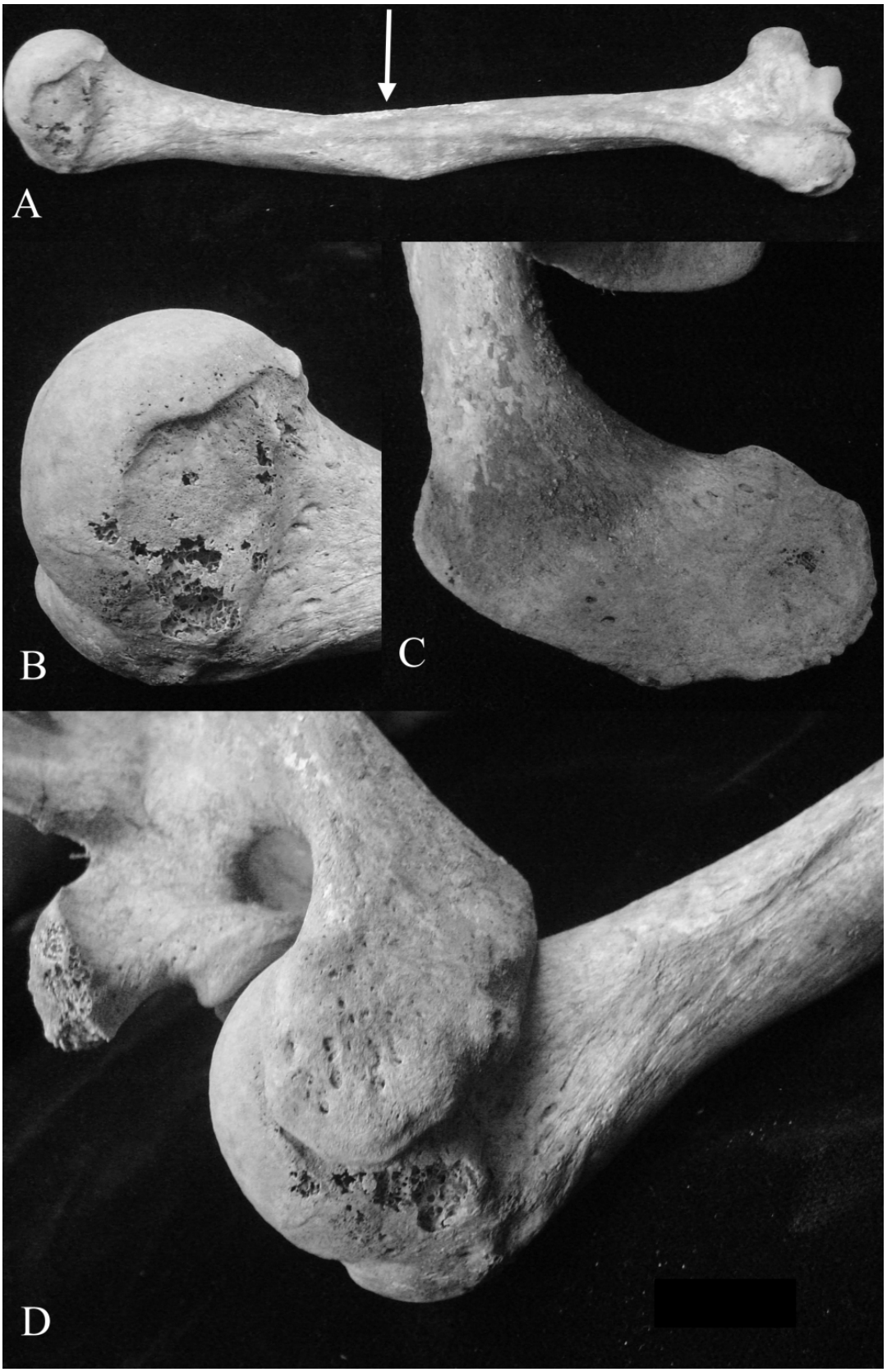


Figure4.9 Longstanding dislocation of the gleno-humeral joint caused the formation of an articulation surface between the humeral head and the inferior surface of the acromion process of the scapula in this 40–55 year old male (GLD N74.5). (a) The fracture of the humerus caused medial rotation of the distal end of the bone. The articulation surface between (b) the humeral head and (c) inferior acromion (d) can also be seen.

4.3.3 Amputations

While the dislocation of joints may not have received immediate care, evidence of medical intervention was noted in this sample with six individuals exhibiting healed or unhealed amputations. This included one amputation of the femur, two of the tibia and fibula, one of the foot at the ankle, one of the humerus and one of the proximal radius and ulna (see Table 4.5).

A 30–35 year old male (GLD N38.2) presented with an amputation of the right femur, approximately 106mm distal from the proximal end (see Figure 4.10). This person did not survive the procedure, as the amputated limb was buried with the individual and the amputation showed no macroscopic indication of healing. The reason for the amputation had most likely been a compound fracture of the distal femur (as observed during analyses of the remains) that had become severely infected, as was indicated by the reactive new bone growth present around the fractured end.

Examples of well-healed amputations included an amputation of the left tibia, fibula and foot (GLD N34.3) just distal to the proximal end of the left tibia and fibula (see Figure 4.11), as well as an amputation of the left foot (GLD S2.6). These amputations developed into the very characteristic peg shaped distal bone end associated with healed amputations, accompanied by closure of the medullary cavity (Mann & Murphy, 1990). Ankylosis of the distal ends of the left tibia and fibula occurred following amputation of the foot.

Table 4.5 Prevalence and location of amputations.

Number	Sex	Age(years)	Fem	Tib& Fib	Foot	Hum	Ul& Ra	T	%
GLD N34.3	M	30-35		1					
GLD N38.2	M	25-29	1						
GLD N8.1amp	M	Adult		1					
GLD S2.6	M	35-45			1				
GLD S2.7b	U	U				1			
GLD S2.7c	U	U					1		
Total n = 107			1	2	1	1	1	6	5.6

M – male, U – unknown, Fem – Femur, Tib – Tibia, Fib – Fibula, Hum – Humerus, Ul – Ulna, Ra – Radius, T – Total

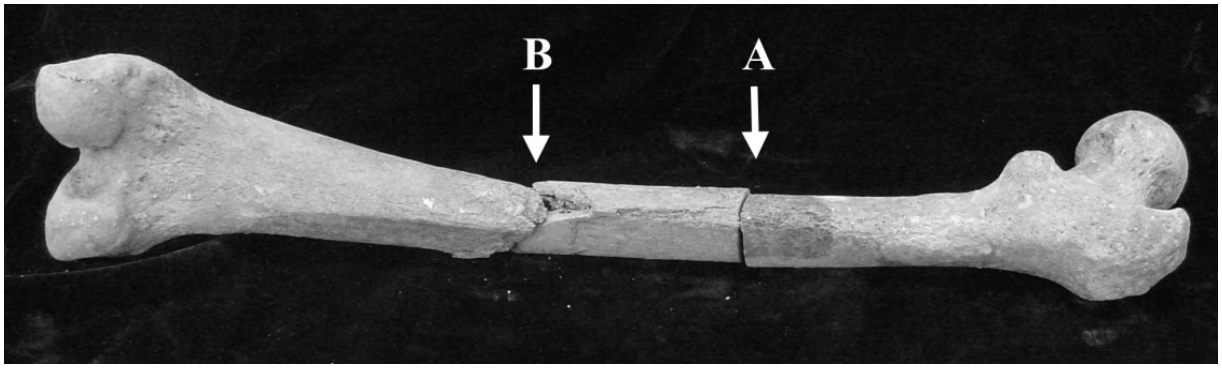


Figure 4.10 Right femur of a 25–29 year old male, amputated (A) following a compound fracture and (B) infection (GLD N38.2).

Figure 4.11 Well-healed amputation of the left tibia and fibula of a 30–35 year old male (GLD N34.3).

Apart from the abovementioned individuals who showed signs of amputations, three separate amputated limbs were also excavated. These amputations were of great interest, since some yielded information regarding the reason for the procedure.

The first amputated limb was composed of a left tibia, fibula and foot amputated just distal to the knee (GLD N1.8 (b)). The limb was found in a coffin with the complete skeleton of a 15–19 year old female. The cause for this amputation was severe infection of the lower leg, which had most likely commenced at the foot. Serious signs of infection with extensive remodeling and new bone formation on the left talus and calcaneus were observed along with signs of infectious new bone deposition on the tibia and fibula. A radius and ulna, amputated just distal to the elbow (GLD S2.7c), was also recorded. Signs of infectious new bone formation were present on the proximal half of the bones. The last amputated element was a humerus (GLD S2.7b). This fragment of bone was amputated at both the distal and proximal ends, as can be seen in Figure 4.12.

The initial distal amputation had most likely become infected shortly after the procedure was done and accordingly, the amputation was extended proximally.

Figure 4.12 Humeral shaft with evidence for amputation on the proximal and distal ends. Signs of infection (arrow) can be seen on the distal end of the bone (GLD S2.7a).

4.4 Discussion

4.4.1 Evidence of interpersonal violence and strenuous activity among 19th century migrant labourers in Kimberley

As this sample population was comprised of individuals who most likely died at the surrounding hospitals in Kimberley, a high prevalence of skeletal pathology can be expected. Accordingly, the frequency of disease in this sample should be interpreted with caution, since it is not representative of the rest of the 'healthy' individuals from which the sample population was taken. Conversely, the assessment of healed trauma, such as the healed fractures observed in this study, can give a more accurate view into the lives of the people from which the sample came, since these lesions were not the reason for hospitalisation.

The frequency and variation in fracture type within a population can yield important information regarding lifestyle, interaction with the environment and the nature of medical attention that was available at the time (Steinbock, 1976; Kilgore *et al*., 1997). Parry fractures of the ulna, blunt trauma to the skull and evidence of cut marks by a sharp object are all indicative of interpersonal violence (Smith, 1996; Jurmain & Bellifemine, 1997; Kilgore *et al*., 1997; Lovell, 1997; Jurmain, 2001; Ortner, 2003; Judd, 2004). Femoral,

tibial and humeral fractures, on the other hand, are usually related to accidents such as falls (Kilgore *et al*., 1997).

The high prevalence of cranial fractures within this population (24%) (20 fractures observed in 84 skulls) is suggestive of interpersonal violence, as was also suggested in a sample from Chile where 24.6% (n=17) of individuals presented with cranial fractures (Standen & Arriaza, 2000). Most of the fractures observed on the cranial vaults were circular in shape, relatively similar in size and seemed to have been caused by a weapon such as a knobkerrie, although this cannot be stated with any certainty. A knobkerrie is a traditional South African club or stick shaped weapon with one rounded end. All cranial fractures were due to blunt-force trauma and several other weapons or even rocks can produce the same results (Jurmain & Bellifemine, 1997). Thus, although the lesions observed in this study had a preference toward the left side of the skull, suggesting possible right handed assault from the front, it should also be considered that the high prevalence of cranial fractures may be partly related to mining accidents such as rock falls, which were also recorded in archival documents. Therefore, these fractures cannot be exclusively attributed to interpersonal violence.

The prevalence of lesions suggesting interpersonal violence did however concur with the historical accounts of violence amongst the black labourers in Kimberley. The notion of violence as a symbol of masculinity and group affiliation was very strong in this population, leading to fights between various groups. These fights were a means by which leaders were selected and justice was served. An Anglican clergymen reported that ‘‘tribal fights and murders occurred every weekend’’ (Harries, 1994:58). According to records, weapons such as knobkerries, fighting sticks and pick handles were used (Harries, 1994).

Levels of interpersonal violence have been shown to increase when periods of environmental deterioration, sudden population growth and an increase in competition for resources are present within a population (e.g. Torres-Rouff & Costa Junqueira, 2006). The discovery of diamonds in Kimberley was a catalyst for the creation of these conditions. Numerous individuals went to Kimberley to seek their fortune, or employment, causing a dramatic growth in population numbers (Roberts, 1976; Harries, 1994). When considering that the study sample was most likely migrant labourers from various parts of the country, aggressive behaviour may also have been spurred by cultural differences (Harries, 1994). Furthermore, the increase in population numbers would inevitably have caused competition for resources, especially among the labourers of lower socioeconomic status. The high

prevalence of scurvy reported in archival documents for this population supports a state of limited fresh nutritional resources (Van der Merwe, 2007). Few women were present in Kimberley, as suggested by the few female skeletons excavated as well as the archival records. This fact may have increased the level of social conflict and competition. Other factors such as regular over-indulgence of liquor, labour disputes and skirmishes over the theft and illegal selling of diamonds may also have led to various violent confrontations between labourers and their employers or overseers (Turrell, 1987; Harries, 1994).

According to Lovell (1997), high fracture risks are associated with occupations generally restricted to men, such as agriculture, mining and forestry, while domestic activities in developing countries (such as carrying water and firewood) also pose a high risk of fractures to females. Mining accidents occurred frequently in Kimberley and included individuals falling down mine shafts, getting killed in rock falls, drowning in mud rushes and being run over with wagons, carts or trams, to name but a few (CGHVPP, 1901; Knight, 1978; Turrell, 1987; Harries, 1994). The prevalence of long bone fractures, spondylolysis, longstanding subluxations as well as some of the cranial fractures within the Gladstone population may therefore be a reflection of the high-risk environment to which these individuals were subjected to.

Separation of the neural arch or spondylolysis is a condition mostly recognised by the bilateral fracture of the pars articularis of vertebrae L4 or L5 (Merbs, 1989; Arriaza, 1997). Lane (1893) noted that spondylolysis is associated with strenuous physical activity and occurs frequently in individuals participating in heavy labour.

An investigation into the prevalence of this condition among 372 black South African skeletons from the Raymond Dart collection was conducted by Eisenstein (1978), who found that 3% of the sample population presented with spondylolysis (Eisenstein, 1978). Unfortunately, the exact number of individuals presenting with the condition, as observed by Eisenstein (1978), was not stated in the literature, making statistical comparison difficult. The observed prevalence of the condition in the Gladstone sample (8.5%) does, however, seem higher than what would be expected in the average South African black population.

Spondylolysis is caused by repetitive increased compression of the posterior elements of the vertebrae due to hyperextension of the back or increased shearing forces due to repeated flexion. During hyperextension of the back, the joints of adjacent vertebrae become locked together, causing an increase in stress exerted on the bone (Arriaza, 1997).

The reason for the high prevalence of spondylolysis in this population is clear: activities associated with mining will include a higher-than-average prevalence of hyperflexion and hyperextension of the back, which will inevitably increase the likelihood of spondylolysis in individuals who are genetically susceptible (Lovell, 1997; Earl, 2002). Therefore, the relatively high prevalence of spondylolysis within this sample is suggestive of participation in the continuous strenuous physical activities most likely associated with mining.

Thus, it can be concluded that the skeletal evidence concurs with the historical documents and that individuals within this sample were exposed to high levels of interpersonal violence, a hazardous working environment, as well as strenuous labour requirements.

4.4.2 Medical care in Kimberley at the close of the 19th century

The clear evidence of saw marks perpendicular to the long axis of the bone observed on the amputated limbs supports the assertions made in historical documents that the Gladstone cemetery was used as a burial ground by Kimberley and other surrounding hospitals. Several archival documentations of amputations are available from the Kimberley Hospital (CGHVPP, 1885). According to these records, up to 35 amputations were done annually, which amounted to approximately 50% of all operations performed in Kimberley Hospital (CGHVPP, 1885). The operations were most likely done under general anaesthesia. Anaesthesia with ether was first performed in Grahamstown (South Africa) in June 1847, and by the 1850s chloroform was being used (Laidler & Gelfand, 1971).

Unfortunately, no documentation suggesting the possible reasons for these amputations was available. However, two therapeutic reasons for the amputation of a limb can be suggested. First is amputation after injury, resulting from such severe crushing of the limb that it had no chance of healing. When considering the types of mine accidents mentioned earlier, crushing and compound fractures such as these may have been frequently encountered in Kimberley. The second reason for amputation is severe infection of a part of a limb. Evidence of infectious lesions found on amputated limbs (such as GLD N38.2, GLD N8.1b, GLD S2.7b and GLD S2.7c) suggests that some amputations were indeed the result of severe infections. This is plausible in light of the fact that antibiotics were not yet available for the treatment of infectious conditions (Quetel, 1990). Thus, the amputation of the infected body part was the only way to prevent spreading of the infection.

The presence of some well-healed and remodeled fractures within this population also indicates that medical care, although sometimes limited, was available to treat fractures. This has been confirmed historically, since hospital records refer to the treatment of injuries, which most likely would have included fractures (CGHVPP, 1899; 1901).

In summary, the high prevalence of cranial fractures within this population is suggestive of high levels of interpersonal violence (Jurmain & Bellifemine, 1997; Standen & Arriaza, 2000). Cultural differences among migrant workers, competition for resources, few females, regular overindulgence in alcohol and labour issues most likely all contributed to the occurrence of violent events within and among labourers and their employers (Harries, 1994; Turrell, 1987).

The prevalence of fractures of long bones and possibly some of the cranial fractures, as well as the presence of spondylolysis and longstanding subluxations, are indicative of the strenuous work and high-risk environment these individuals were exposed to. Medical treatment was available to these individuals, bearing in mind the presence of well-reduced fractures and evidence of amputation for medical purposes.

This study has provided a valuable glimpse into the working environment, social situation and medical facilities in Kimberley at the close of the 19th century. More than 14 million carats of diamonds was extracted from a hole measuring approximately 1200m wide and 800m deep, which used to be Colesberg Kopje. This research offers recognition to those unnamed labourers who unknowingly played a crucial role, not only in the history, but also in the economic growth of South Africa.

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