The use of corsetry to treat Pott's disease of the spine from 19th Century Wolverhampton, England.

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Abstract

Corsets have been used both to create a fashionable silhouette and as an orthopaedic treatment for spinal conditions, but skeletal changes associated with the use of corsetry are rarely reported on in the palaeopathological literature. Here, we report on a 19th-century adult male with Pott's disease of the vertebral column and related vertebral compression deformities, which probably result from the use of a corset. Wolverhampton HB40 presented destruction of the vertebral bodies of T6 to L4, ankylosis of the apophyseal joints of L1 and L2 and an angular kyphosis of the lumbar region, the result of tuberculosis. The presence of flattened spinous processes and bilateral acute angulation of multiple ribs in the lower thoracic region is indicative of plastic deformation caused by the use of the corset. The presence of both of these changes in an adult male, at a time when the use of cosmetic corsets by men was in decline, suggests that the compression trauma was the result of an orthopaedic corset used to correct the defective posture resulting from tubercular kyphosis, although corset use to obtain a fashionable silhouette cannot be ruled out.

Key Words

Corsetry, Kyphosis, Pott's disease, Tuberculosis, Wolverhampton, 19th Century

1. Introduction

Tuberculosis (TB) is a chronic infectious disease caused by *Mycobacterium bovis* and *Mycobacterium tuberculosis* and was a significant cause of morbidity and mortality across England from the early medieval period through to the late-19th century (Aufderheide and Rodrigues-Martin, 1998). Skeletal TB is always secondary to a primary infection in the lung, gastrointestinal tract or lymph nodes that spreads to bone via the lymphatic system or blood stream (Ebnezar, 2005). Once within bone the tubercle bacilli tend to exhibit a predilection for the axial skeleton, particularly the haemopoietic centres, due to their high metabolic and circulatory rates, with the lower spine being the most common location for skeletal lesions (Ortner, 2003). Spinal TB predominantly affects the vertebral bodies, most notably the anterior portions with involvement of the neural arches being an extremely rare occurrence. The destructive nature of the disease commonly results in the collapse of the vertebral bodies creating an angular kyphosis known as a gibbus or Pott's disease of the spine (Ortner, 2008). Almost 3% of all cases of TB develop a severe spinal kyphosis (Tuli, 1995), for which traction via corsetry and braces has been a common treatment since the late medieval period (Ponseti, 1991).

Corsetry refers to garments of clothing that provide a rigid frame that can be tightened to manipulate and hold the wearer's torso into a desired shape for either fashionable or medical purposes. Historically one of the most common uses of corsets was to slim the body and enable the wearer to conform to the fashionable silhouette of the period. For women this usually meant attaining a 'wasp-waisted' figure by emphasising the hips and bust while reducing the waist (Steele, 2001, Stone, 2012; see Figure 1). For men the dominant fashion was a lean figure boasting broad shoulders and a narrow waist, which was also often achieved using corsetry. Although notoriously associated with the 'Dandies'[1] of the 18th and early 19th centuries, male corsets were openly advertised by tailors and men from every social stratum were known to have worn them (Cole, 2010, Schwarz, 1979). Despite the overwhelming association of corsets with fashion, these restrictive garments have a more extensive history within the field of orthopaedic medicine, especially with regard to the treatment of spinal deformities (Wiener, 1896). Orthopaedic corsets have been produced in multiple forms for

[1] A man unduly concerned with looking stylish and fashionable

centuries and of these, frame corsets and braces have been regularly prescribed to treat spinal diseases such as lumbar disc lesions, spondylosis, spondylolisthesis, TB, ankylosing spondylitis and scoliosis (Ueyoshi and Shima, 1985). Indeed, throughout the 19th century the primary treatment for Pott's disease involved the prolonged use of corsets and braces in an attempt to correct defective posture caused by the spinal deformity (Turner, 1913). Due to the compressive nature of these garments, long-term use could lead to skeletal changes in the thoracic region, which can be detected during osteological analysis of the remains (Cross, 2006, Groves et al., 2003, Miles et al., 2008, Wescott et al., 2010). The compressive forces imposed on the thoracic cavity by these corsets create an anterior displacement of the ribs and anterior flattening of the spinous processes of the vertebrae. The impact of these external stressors is minimised by plastic deformation of the skeletal elements, facilitated by the high collagen content of bone, which eventually results in an abnormal remodelling of the thoracic cavity (Figure 1) (Cross 2006).

<FIGURE 1 HERE>

2. Wolverhampton HB40

St Peter's Collegiate Church overflow cemetery in Wolverhampton was excavated between October 2001 and January 2002 (Adams and Colls, 2007). The overflow cemetery was in use between 1819 and 1853; a total of 150 human burials were recovered (Arabaolaza et al., 2007). Wolverhampton burial HB40 was recovered from an earth-cut stacked grave above the interred remains of a previously published individual, HB39, who suffered from metastatic multicentric osteosarcoma (Ortner et al., 2010, Adams and Colls, 2007).

Burial HB40 consists of the incomplete remains of an adult human skeleton. The burial had been partially destroyed due to clearance and construction work prior to excavation, which is responsible for the incomplete nature of the remains (Figure 2); the lack of the ossa coxae specifically, dictated the restricted number of age estimation and sex assessment techniques employed during analysis. Sex assessment was conducted using skull morphology (Walker, 2008) and metrical analysis of the glenoid fossa, epicondylar breadths and vertical head of the humerus (Bass, 2005). Closure of the cranial vault sutures and lateral-anterior cranial

sutures (Meindl and Lovejoy, 1985), alongside transition analysis (Boldsen et al., 2002), were used to estimate the age of the individual. Osteological analysis of Wolverhampton HB40 assessed the individual to be a probable male aged between c.20 – 35 years (middle adult).

<FIGURE 2 HERE>

3. Palaeopathology

The pathological alterations observed include severe destruction of the anterior portions of the vertebral bodies of L1 and L2, which led to extensive cavitation of both bodies and the eventual collapse of L1 onto L2 creating an extreme wedge shape (Figure 3). These two vertebrae had preserved neural arches with complete fusion through their apophyseal joints creating an angular kyphosis (Figure 4). In addition to this, there were large lytic lesions on the anterior surfaces of the lower thoracic vertebrae (T6-T12) and all the lumbar vertebrae present (L1-L4), exposing the trabecular bone. Significantly, these lesions did not skip any vertebrae and there was no bone proliferation associated with them. The differential diagnoses for these lesions include tuberculosis, brucellosis or non-specific infection (Capasso, 1999, Ortner, 2003). As all of these lesions were focused around the anterior portions of the vertebral bodies with no skip lesions or bone proliferation, the cause is unlikely to be non-specific infection or osteomyelitis. The nature and distribution of these lesions with the angular kyphosis are more indicative of tuberculosis than brucellosis, but with the absence of the pelvis and lower limbs and the absence of inflammatory change of the visceral surface of the ribs, a distinction between pulmonary tuberculosis and gastrointestinal tuberculosis cannot be made (Curate, 2006, Mays and Taylor, 2003, Ortner, 2003).

<FIGURES 3 AND 4 HERE>

The skeleton also exhibited abnormal alterations of the bones that formed the thorax. The spinous processes of thoracic vertebrae T5-T10 were markedly flattened anteriorly, with a slight curvature towards the left, yet they exhibited no other changes associated with disease (Figure 5). The angle of the ribs was more acute than normal, with an anterior displacement

of the rib bodies when articulated with the vertebrae. This change was bilateral, affecting ribs 6-10 on the left side and ribs 5-10 on the right (Figure 6). The differential diagnosis for these alterations includes healed rickets, pigeon chest (*pectus carinatum*) and plastic deformation caused by compression. Rickets may account for the abnormal angle of the ribs, but not the alteration to the vertebrae. In addition, the skeleton did not exhibit any other skeletal manifestations of the disease, therefore rickets is not a likely cause (Ortner, 2003). Although *pectus carinatum* accounts for the anterior displacement of the ribs and is predominately seen in males, it does not account for the anterior flattening of the spinous processes, and there is no anterior bowing of the sternum (Groves et al., 2003). A radiograph of the ribs shows no evidence of healed trauma. The high collagen content of bone gives it an elastic quality that allows it to accommodate external stress by plastically deforming to minimise the impact of the force, and this reaction is most resistant to compressive forces (Lovell, 2007). The changes observed are consistent with plastic deformation due to compressive forces in the lower thorax, and we argue that they are consistent with the use of a corset (Groves et al., 2003, Cross, 2006, Stone, 2012, Moakes, 2013).

<FIGURES 5 AND 6 AND 7 HERE>

Further pathological alterations observed included ante-mortem fractures of the left orbital rim and nasal bones as well as a circular depression on the antero-lateral aspect of the capitulum on the left humerus consistent with osteochondritis dissecans. Schmorl's nodes were present on the vertebral end plates of six lower thoracic and the first three lumbar vertebrae. Eburnation was observed on the inferior apophyseal facets of T11 and the superior apophyseal facets of T12, which is pathognomonic of osteoarthritis (Rogers and Waldron, 1995). These lesions are believed to relate to different disease processes and will not be discussed further.

4. Discussion

Throughout the 19th century, the industry and population within Wolverhampton underwent a period of rapid growth, resulting in a higher prevalence of diseases associated with high density occupation and poor living conditions (Wohl, 1983). This heavy industrial activity

within the city inevitably led to significant levels of air pollution, resulting in an increased prevalence of pulmonary diseases, such as tuberculosis (Adams and Colls, 2007). Tuberculosis was rife during the 19th century due to the overcrowded, poor living conditions and an increased consumption of dairy produce, and as a result tuberculosis was responsible for the majority of deaths in urban Victorian England (Aufderheide and Rodrigues-Martin, 1998). Indeed, documentary evidence and grave memorials show that tuberculosis was a significant factor affecting people's health and mortality within Wolverhampton (Adams and Colls, 2007). It is therefore unsurprising that HB40 exhibited significant spinal manifestations of this disease, and although it is the only skeleton from the St. Peter's Collegiate Church overflow cemetery with skeletal evidence of tuberculosis, it should be noted that skeletal changes are only seen in a small percentage of cases (Resnick and Niwayama, 1995), and only 150 skeletons were recovered from the cemetery.

The abnormal changes displayed in the lower ribs and spinous processes of HB40's thoracic vertebrae may be linked to the skeleton's spinal manifestations of tuberculosis. Since the early 18th century, corsets have been used as a corrective treatment for spinal deformities and defective posture (Ohry, 2011), especially as a treatment for Pott's disease as illustrated by Figure 7 (Wiener 1896). In fact, modern back supports were adapted from the corsets originally designed to treat spinal tuberculosis (Norton and Brown, 1957). However, the fact that the men of past populations also wore corsets in pursuit of fashion cannot be overlooked. This fashion phenomenon was most popular during the 18th century, but continued, although in a diminished capacity, into the early 19th century, mostly amongst aristocratic society (Steele, 2001). Therefore, while the close association of the plastic deformation of the spine and ribs with evidence of Pott's disease suggests that, in this case, the changes observed may be due to the regular use of a corset to correct the defective posture associated with Pott's disease, the possibility that the plastic deformation occurred before the onset of disease cannot be ruled out. Despite the uncertainty surrounding the reason for its initial use, it is clearly evident that some form of corsetry was utilised by this individual. As such HB40 is of particular interest, as this type of thoracic deformation has only been described in a very small number of archaeological skeletons, all of whom were female individuals with no spinal manifestations of TB (Groves et al., 2003, Miles et al., 2008, Wescott et al., 2010, Walker, 2012).

<FIGURE 8 HERE>

5. Conclusion

The deformities observed in the thoracic cavity of this adult male skeleton from the 19th century overflow cemetery of St. Peter's Collegiate Church, Wolverhampton show that this individual was probably using a corset. However, it is unclear whether its use was orthopaedic or cosmetic in nature. It has been well documented in medical literature that orthopaedic corsets have long been used to treat spinal deformities, especially in relation to Pott's disease (Beasley, 1982, Ahn, 1968, Peltier, 1993). However, the authors are currently unaware of any documentation pertaining to the lasting effects of these treatments on the skeleton, or how these changes may differ from those seen as a result of corsets worn to attain the fashionable silhouette of the period. Indeed, palaeopathological literature pertaining to any type of corset use is scarce and we are unaware of any publications pertaining specifically to male corset use or skeletons exhibiting corsetry deformation in conjunction with Pott's disease, despite the historical literature indicating corsetry to have been a regular treatment for Pott's disease.

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References

Adams, J. and Colls, K. (2007) *'Out of darkness, cometh light' Life and Death in Nineteenth-Century Wolverhampton: excavation of the overflow burial ground of St Peter's Collegiate Church, Wolverhampton 2001-2002. BAR British Series 442* Oxford, UK: Archaeopress.

Ahn, B. H. (1968) 'Treatment for Pott's Paraplegia', *Acta Orthopaedica Scandinavica,* 39, pp. 145-160.

Arabaolaza, I., Ponce, P. and Boylston, A. (2007) 'Skeletal Analysis', in Adams, J. & Colls, K. (eds.) *'Out of darkness, cometh light' Life and Death in Nineteenth-Century Wolverhampton: excavation of the overflow burial ground of St Peter's Collegiate Church, Wolverhampton 2001-2002 BAR British Series 442*. Oxford, UK: Archaeopress.

Aufderheide, A. C. and Rodrigues-Martin, C. (1998) *The Cambridge Ecyclopedia of Human Palaeopathology.* Cambridge, UK: Cambridge University Press.

Banfield, M. A. (2012) *The Posture Theory: the physical cause of undetectable illness* Modbury, Australia: M.A. Banfield.

Bass, W. M. (2005) *Human Osteology: a laboratory field manual.* 5th edn. Columbia: Missouri Archaeological Society.

Beasley, A. W. (1982) 'The Origins of Orthopaedics', *Journal of the Royal Society of Medicine,* 75, pp. 648-655.

Bigg, H. R. H. (1882) *Spinal Curvature: Comprising a description of the various types of curvature of the spine with the mechanical appliances best suited for their treatment.* London, UK: J & A Churchill, p. 75.

Boldsen, J. L., Milner, G. R., Konigsberg, L. W. and Wood, J. W. (2002) 'Transition Analysis: A New Method for Estimating Age from Skeletons', in Hoppa, R.D. & Vaupel, J.W. (eds.) *Paleodemography: Age Distributions from Skeletal Samples*. Cambridge, UK: Cambridge University Press, pp. 73-106.

Capasso, L. (1999) 'Brucellosis at Herculaneum (79AD)', *International Journal of Osteoarchaeology,* 9, pp. 277-288.

Cole, S. (2010) *The Story of Mens Underwear.* New York, USA: Parkstone International.

Cross, A. W. (2006) *Wasp-Waisted Women: skeletal modifications of corsetry.* Human Osteology and Palaeopathology, University of Bradford.

Curate, F. (2006) 'Two Possible Cases of Brucellosis frim Clarist Monastery in Alcácer do Sal, Southern Portugal', *International Journal of Osteoarchaeology,* 16, pp. 453-458.

Ebnezar, J. (2005) 'Skeletal Tuberculosis', *Essentials of Orthopaedics for Physiotherapists: Vol. 25*. New Delhi: Jaypee Brothers Medical Publishers Ltd, pp. 367-376.

Groves, S., Roberts, C., Johnstone, C., Hall, R. and Dobney, K. (2003) 'A High Status Burial from Ripon Cathedral North Yorkshire, England: a differential diagnosis of a chest deformity', *International Journal of Osteoarchaeology,* 13, pp. 358-368.

Lovell, N. C. (2007) 'Analysis and interpretation of skeletal trauma', in Katzenberg, M.A. & Saunders, S.R. (eds.) *Biological Anthropology of the Human Skeleton.* 2nd ed. Hoboken, NJ, USA: John Wiley & Sons Inc., pp. 341-386.

Mays, S. and Taylor, M. G. (2003) 'A First Prehistoric Case of Tuberculosis from Britain', *International Journal of Osteoarchaeology,* 13, pp. 189-196.

Meindl, R. and Lovejoy, C. (1985) 'Ectocranial Suture Closure: A revised method for the determination of skeletal age at death based on the lateral-anterior sutures', *American Journal of Physical Anthropology,* 68(1), pp. 57-66.

Miles, A., Powers, N., Wroe-Brown, R. and Walker, D. (2008) *St. Marylebone Church and Burial Ground in the 18th to 19th Centuries: excavations at St. Marylebone School,*

1992 and 2004-6. MoLAS Monograph 46 London, UK: Museum of London Archaeological Service.
Moakes, N. (2013) *Straight-laced? A Geometric and Morphometric Characterization of Corset Deformation in the Ribcage.* Forensic Osteology, Bournemouth University, Unpublished.
Norton, P. L. and Brown, T. (1957) 'The Imobilising Efficiency of Back Braces: their effect on the posture and motion of the lumbosacral spine', *The Journal of Bonne and Joint Surgery,* 39-A(1), pp. 111-139.
Ohry, A. (2011) 'Spinal Theraputics Before Our Times', *Progress in Health Sciences,* 1(2), pp. 196-199.
Ortner, D. J. (2003) *Identification of Pathological Conditions in Human Skeletal Remains.* 2nd edn. London, UK: Academic Press.
Ortner, D. J. (2008) 'Differential Diagnosis of Skeletal Lesions in Infectious Diseases', in Pinhasi, R. & Mays, S. (eds.) *Advances in Human Palaeopathology*. West Sussex, England: Wiley & Sons Ltd, pp. 191-214.
Ortner, D. J., Ponce, P., Ogden, A. and Buckberry, J. (2010) 'Multicentric Osteosarcoma Associated with DISH, in a 19th Century Burial from England', *International Journal of Osteoarchaeology,* 22, pp. 245-252.
Peltier, L. F. (1993) *Orthopaedics: a history and iconography.* San Francisco, Ca, USA: Norman Publishing.
Ponseti, I. V. (1991) 'History of Orthopardic Surgery', *The Iowa Orthopaedic Journal,* 11, pp. 59-64.
Resnick, D. and Niwayama, G. (1995) 'Osteomyelitis, septic arthritis and soft tissue infection: organisms', in Resnick, D. (ed.) *Diagnosis of Bone and Joint Disorders.* 4th ed. Edinburgh: Saunders.
Rogers, J. and Waldron, T. (1995) *A Field Guide to Joint Disease in Archaeology.* Chichester, UK: John Wiley & Sons Ltd.
Schwarz, G. S. (1979) 'Society, Physicians and the Corset', *Bulletin of the New York Academy of Medicine,* 55(6), pp. 551-590.
Steele, V. (2001) *The Corset: a cultural history.* London: Yale University Press.
Stone, P. K. (2012) 'Binding women: ethnology, skeletal deformations, and violence against women.', *International Journal of Paleopathology,* 2(2-3), pp. 53-60.
Stone, P. K. (2012; see Figure 1) 'Binding women: ethnology, skeletal deformations, and violence against women.', *International Journal of Paleopathology,* 2(2-3), pp. 53-60.
Tuli, S. M. (1995) 'Severe Kyphotic Deformity in Tuberculosis of the Spine', *International Orthopaedics,* 19(5), pp. 327-331.
Turner, W. G. (1913) 'The Treatment of Tubercular Spondylitis or Pott's Disease', *Canadian Medical Association Journal,* 3(10), pp. 852-860.
Ueyoshi, A. and Shima, Y. (1985) 'Studies on Spinal Braces', *International Orthopaedics,* 9(4), pp. 255-258.
Walker, D. (2012) *Disease in London, 1st - 19th Centuries: an illustrated guide to diagnosis. MOLA Monograph 56* London, UK: Museum of London Archaeology.
Walker, P. L. (2008) 'Sexing Skulls Using Discriminant Function Analysis of Visually Assessed Traits', *American Journal of Physical Anthropology,* 136, pp. 39-50.
Wescott, D., Brinsko, K., Faerman, M., Golda, S., Nichols, J., Spigelman, M., Stewart, B., Streeter, M., Tykot, R. and Zamstein, L. (2010) 'A Fisk Patent Metallic Burial Case from Western Missouri: an interdisciplinary and comprehensive effort to reconstruct the history of an early settler of Lexington, Missouri.', *Archaeological and Anthropological Sciences,* 2(4), pp. 283-305.

Wiener, A. C. (1896) 'The Extension Corset and its Indications', *Journal of the American Medical Association*, 26(17), pp. 807-813.
Wohl, A. S. (1983) *Endangered Lives: public health in Victorian Britain.* Cambridge, UK: University Press.

Figures

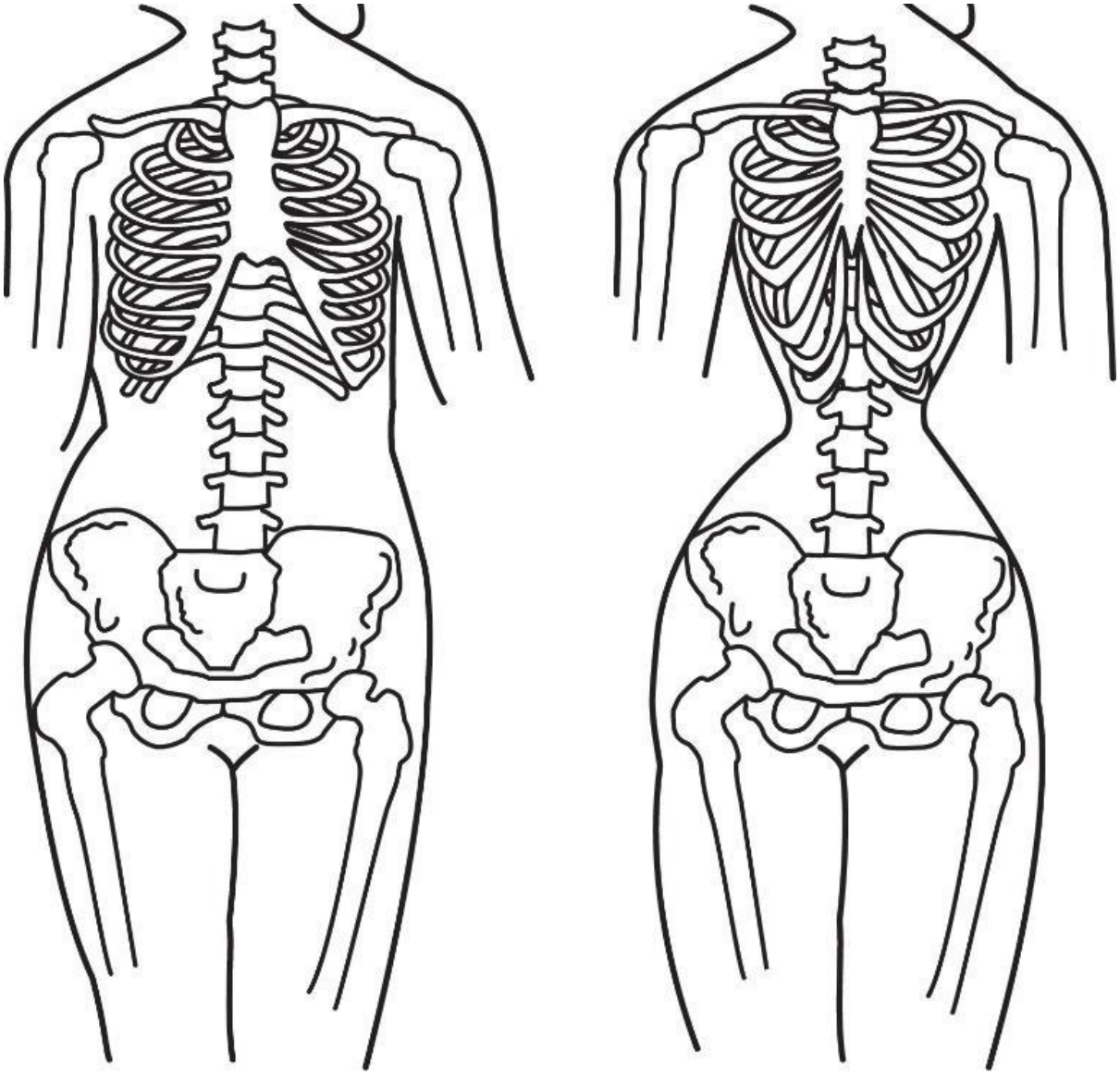

Figure 1: Effects of corsetry on the thoracic cage: normal (left) and with regular corset use (right). Redrawn after (Banfield, 2012)

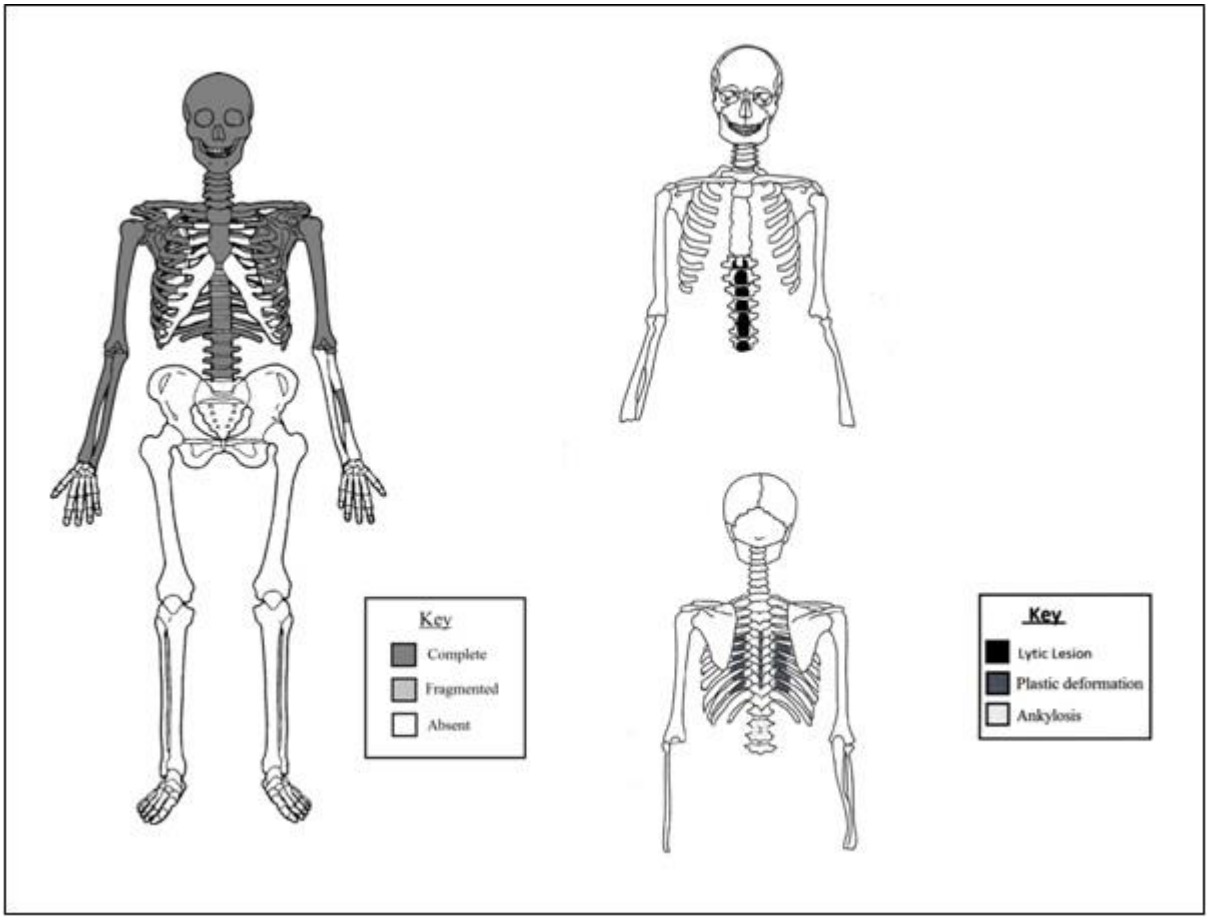

Figure 2: Inventory (left) and distribution of pathological lesions (right)

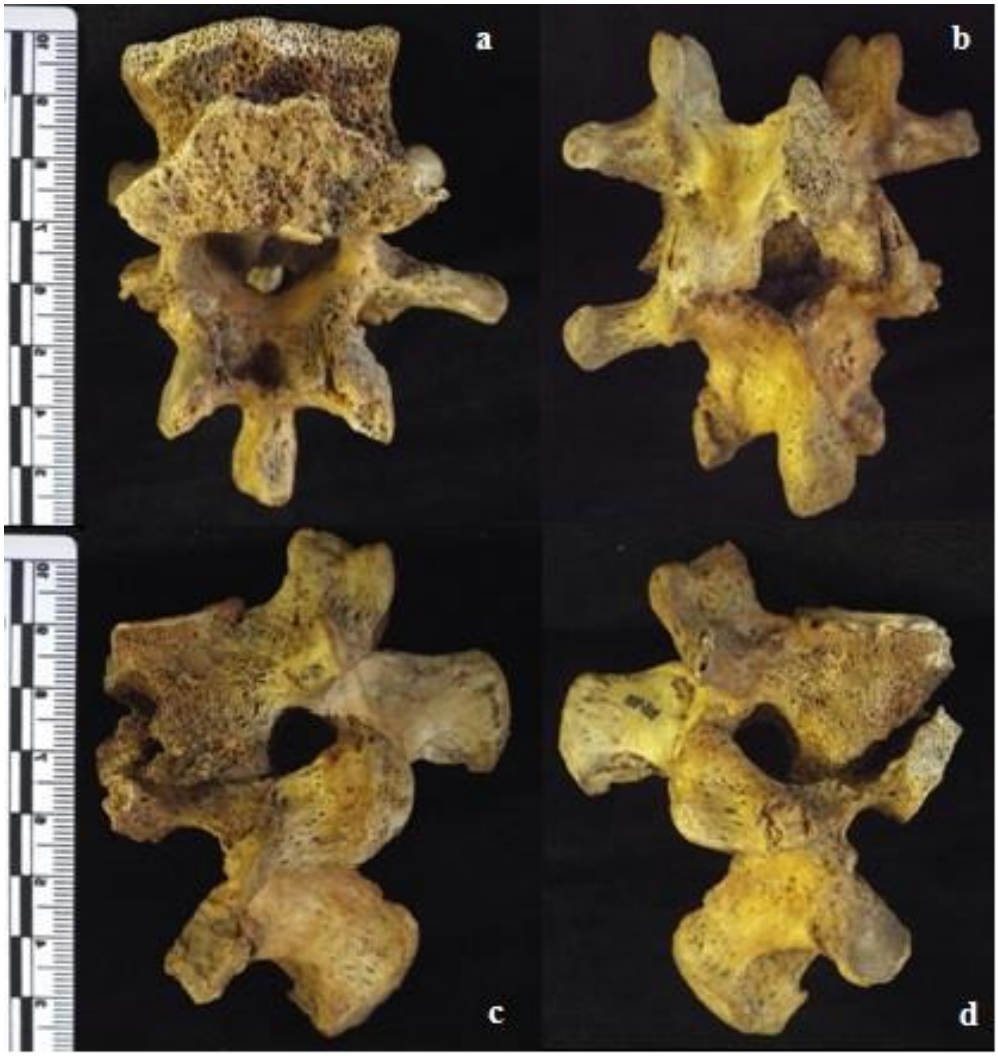

Figure 3: Cavitation and ankylosis of L1 and L2: anterior (a), posterior (b), left (c) and right (d) views

Figure 4: Articulated T12 to L4 showing angular kyphosis caused by collapse and ankylosis of L1 and L2

Figure 5: Articulated T5 to T10 showing anteriorly displaced (flattened) spinous processes

Figure 6: Plastic deformation of a rib from HB40 (left) compared to a non-pathological rib (right), demonstrating acute angle

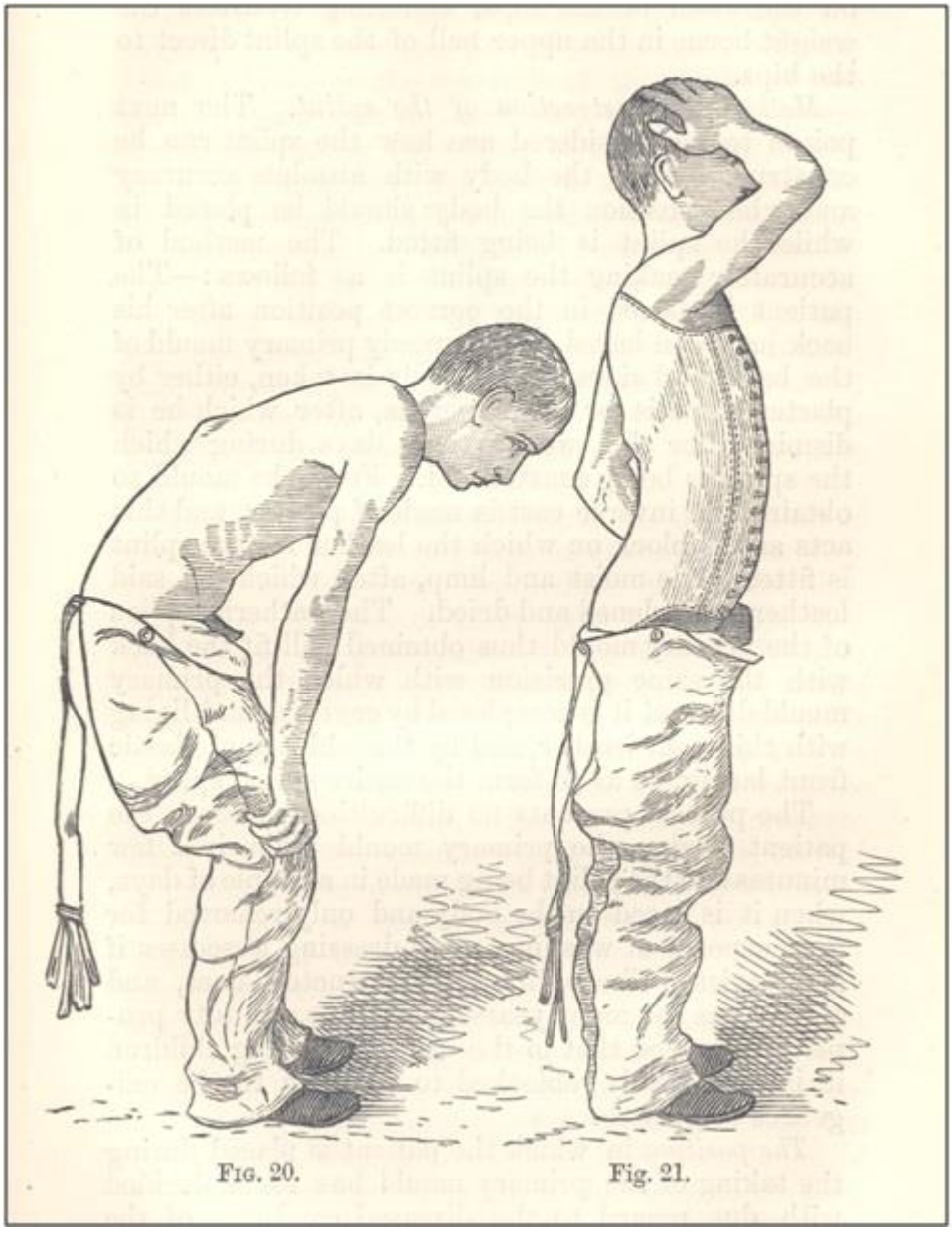

Figure 7: Illustration of a young adult male with Pott's disease (Fig. 20) and the corset used to correct the spinal deformity (Fig. 21) (Bigg, 1882). Reproduced with kind permission of the Thackray Medical Museum, Leeds