Anatomical aspects of *Mycobacterium tuberculosis*–associated destructive cranial lesions

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Case Report

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Abstract

The authors report two cases of destructive cranial lesions associated with *Mycobacterium tuberculosis*–HIV coinfection in a male and female cadaver. Both cadavers were of African origin, from the Western Cape, South Africa. The authors present grossly abnormal tuberculosis–associated lesions of the anterior and middle cranial fossae, involving the ethmoid and sphenoid bones. Both individuals presented with tubercular intrasellar masses and obliteration of the paranasal sinuses. Current literature on cases such as these are extremely rare and others typically focus on lesions of the calvarium. Here we report on the gross anatomical findings as well as the relevant anatomical

aspects of the probable aetiology. Both cases presented here hold interest for medical professionals in Africa and other geographic regions. It further illustrates the importance of understanding the venous drainage of the paranasal sinuses when considering the manifestation and treatment of extrapulmonary TB.

Key words: Mycobacterium tuberculosis, HIV, coinfection, cranial lesions, paranasal sinuses

Introduction

Tuberculosis (TB) and human immunodeficiency virus (HIV) are the two most significant infectious diseases with high mortality rates in developing countries [1]. In 2013, *Mycobacterium tuberculosis* infections in HIV positive individuals affected at least a third of individuals in sub-Saharan Africa alone. South Africa falls within the high-burden list of countries for TB, TB-HIV, and Multi-drug-resistant tuberculosis (MDR-TB) [2,3]. The exact causes of death in some cases of TB-HIV coinfection associated mortality are typically unclear and this emphasises the importance of post-mortem investigations. Such investigations have the potential to elucidate the pathogenesis and further aid the improvement of public-health strategies, improve death certification and assist in clinical education [2]. The skeletal changes associated with TB in modern South African individuals typically involve the vertebral column and ribs. HIV coinfection became more prominent after 1985 [4]. Steyn et al. further continues to state that antibiotic treatment and an increase in patient survival allows more time for the development of lesions [4]. TB-associated lesions of the cranial base are an exception to the rule and more so when considering tubercular intrasellar masses [5]. The two cases presented here, as well as their anatomical considerations, are extremely rare. Both hold value when considering the manifestation and treatment of extrapulmonary TB.

CASE REPORTS

Two gross abnormalities were discovered during routine dissections of crania of formalin-embalmed adult cadavers. Both individuals, according to their death certificates, purportedly died of *Mycobacterium tuberculosis*–HIV coinfection. Prior to maceration, the dura mater within each of the crania were intact and intrasellar masses were found in both, along with extreme ruin of the ethmoid and spheroid bones (Fig. 1A). The skulls were subsequently macerated and prepared for osteological examination. The skull base of the 31-year-old female subject, of African descent, presented with profound TB lesions. In the anterior cranial fossa (Fig. 1A), the ethmoid bone was completely destroyed as well as the jugum of the sphenoid bone. The anterior clinoid processes remained intact. Further abnormalities were seen and included; absence of both orbital plates of the frontal bone and the perpendicular plate of the ethmoid bone. These gross pathological changes resulted in the formation of one continuous cavity with the destruction of the medial portions of the orbital surfaces of the frontal, lacrimal and maxillary bones (Fig. 1A and B). The maxillary sinuses were completely exposed on their medial aspects. The most startling find was the complete destruction of the sella

turcica in the middle cranial fossa and extended as far as the clivus, just posterior of the sphenoid sinus (Fig. 1A and B). The optic and pterygoid canals were intact, however both orbital roofs presented with cribra orbitalia. Similarly, lesions of the ethmoid and sphenoid bones were observed in the cranial base of the 27-year-old male cranium (also of African descent) (Fig. 1C and D). Some lesions appeared to be more advanced than others with those seen in the paranasal sinuses appearing some of the most significant. The medial and lateral walls of the maxillary sinuses were obliterated. The orbital surfaces of the maxillary bones were nearly completely destroyed as well as the middle and inferior nasal conchae (Fig. 2). In both cases, the complete absence of the ethmoid bones was accompanied by a loss of the olfactory fibres and ethmoidal arteries. Furthermore, the structures entering the sphenopalatine foramen, i.e. sphenopalatine artery and vein, posterior superior lateral nasal nerve and nasopalatine nerves, were absent. A tuberculoma, containing calcifications and caseous necrosis, were present in the sella turcica of both crania.

DISCUSSION

Mycobacterial bone infections have increased over the past few decades and are related to the global HIV/AIDS epidemics [6,7]. HIV-related TB is most frequently seen in sub-Saharan Africa and the region is known to contribute towards 79% of such cases worldwide. TB remains the most common HIV-related cause of death and matters are made worse due to the emergence of drug-resistant TB during the 1980s [6]. HIV/AIDS rapidly advances the clinical manifestation of TB and is known to drive dormant cases into full-blown TB in immunocompromised individuals [7].

Mycobacterial infections of bones and joints are well documented and cases affecting the ribs and the spine (Pott's disease and tuberculous vertebral osteomyelitis) have been described extensively. The same holds true for elements of the appendicular skeleton and lytic lesions of the calvarium [4,8]. However, tuberculous involvement of paranasal sinuses and infections of the central nervous system (tuberculoma, tuberculous meningitis, and spinal tuberculous arachnoiditis) are extremely rare [5,9]. More recently, a case of tubercular septic cavernous sinus thrombosis (SCST) was reported and believed to have spread from the paranasal sinuses or dental infections to the veins linked to the cavernous sinus. The microbiology of SCST is well documented [10]. The two cases presented here appear to have followed a similar aetiology. We believe both patients presented with tuberculosis of the ethmoid and sphenoid sinuses which subsequently spread to the cavernous sinus and lead to tubercular intrasellar masses. The aetiology can be explained by considering the venous drainage of the paranasal sinuses as outlined below.

The venous drainage of the maxillary sinuses is either through a single trunk, a continuation of the spheno-palatine vein, or through a series of three venous plexuses. The latter includes the alveolar plexus and anterior and posterior pterygoid plexuses. Of interest is that the posterior pterygoid plexus that is connected to the alveolar plexus and drains into the maxillary and facial veins [11]. The facial vein in turn drains partly into angular and internal jugular veins. It is through the angular vein that infection can spread to the cavernous sinus. The venous drainage of the ethmoidal air cells can reach

the cavernous sinus via the superior ophthalmic vein, which drains into the angular vein, or the pterygoid plexus. The connection of the pterygoid venous plexus with the facial vein is the most likely route of entry to the cavernous sinus. The venae comitantes of the ethmoidal arteries, the ethmoidal veins (both anterior and posterior), drain into superior ophthalmic vein. These routes relate to the venous drainage of the sphenoid sinus, which drains into the posterior ethmoidal vein to the superior ophthalmic vein. In summary, any infection in the paranasal sinuses can reach the cavernous sinus in most instances via the superior ophthalmic vein [11,12].

Both cases presented here illustrate the importance of understanding the venous drainage of the nasal cavity and paranasal sinuses when considering tuberculous involvement of the paranasal sinuses and infections of the central nervous system. The venous communication between these structures, the facial vein and the cavernous sinus should be considered when assessing patients' extrapulmonary TB. Lastly, our findings also reiterate the importance of post-mortem investigations in order to elucidate the cause pathogenesis of TB-HIV coinfections.

ETHICAL APPROVAL

The cadaveric material was handled and processed in accordance with the Anatomical Donations and Post-mortem Ordinance, No. 12 of 1977. No further ethical approval was applicable.

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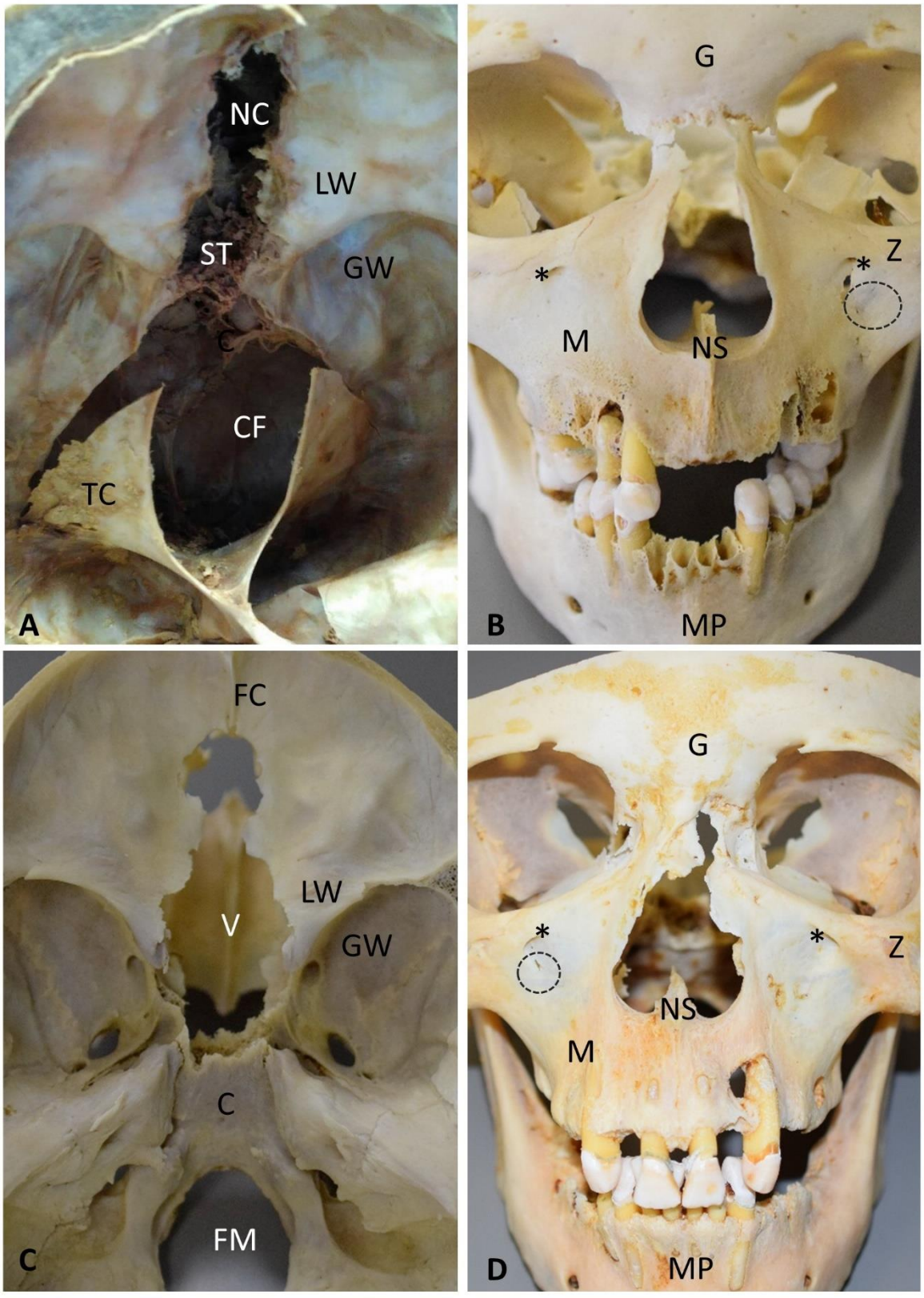

Fig. 1. A: The presentation of the 31-year-old female subject after removal of the brain with the dura still intact. The damage was noted prior to maceration with extreme damage to the ethmoid and sphenoid bones. B: Norma frontalis of the same cranium (after maceration) demonstrating the extent of the tuberculosis-associated bone destruction of the nasal cavity. The asterisks denote the infraorbital foramina and thinning of the anterior wall of the maxillary sinus was observed (dashed circle). C: The 27-year-old male skull (macerated) with damage to the anterior and middle cranial fossae, involving the ethmoid and sphenoid bones. The skull presented with obliteration of the sella turcica and exposed the vomer inferiorly and the same findings were made in the female skulls after maceration. D: Norma frontalis of the same skull demonstrating similar bone lesions compared to the female subject. Legend: C, clivus; CF, cerebellar fossa; FC, frontal crest; FM, foramen magnum; G, glabella; GW, greater wing (of sphenoid); LW, lesser wing (of sphenoid); M, Maxilla; MP, mental protuberance; NC, nasal cavity; NS, nasal spine; ST, sella turcica; TC, tentorium cerebelli; V, vomer; Z, zygomatic bone.

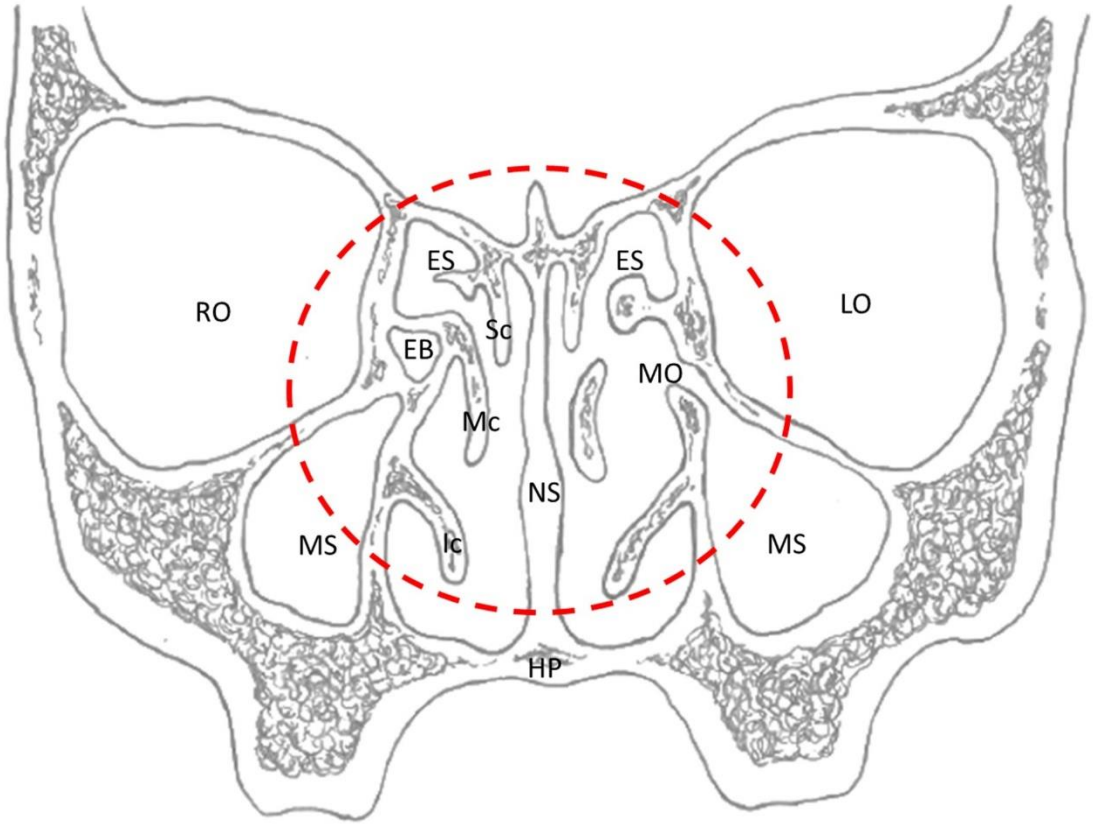

Fig. 2. A diagrammatic representation of the extent of damage to the paranasal sinuses in both crania. The red dashed circle and its content represents the elements of the viscerocranium that were obliterated. Legend: EB, ethmoidal bulla; ES, ethmoidal sinus; HP, hard palate; Ic, inferior concha; Mc, middle concha; MO, maxillary ostium; MS, maxillary sinus; NS, nasal septum; LO, left orbit; RO, right orbit; Sc, superior concha.