Trepanation or Trauma? Differential diagnosis of cranial perforations of an early Iron Age site in Xinjiang, China

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INTRODUCTION
The mechanisms of cranial perforations have kept academia to explore for a long time. This study investigates an adult male skull two perforations unearthed from the early Iron Age site, Xiaoshankou, in Xinjiang, China, suggesting a case of violence. Meanwhile, as many cases of cranial perforations in this region have been diagnosed as trepanation, this study stresses the significance of careful considerations when diagnosing perforations on the skulls in Xinjiang.

BACKGROUNDs
Xiaoshankou Cemetery located in the southwest of Modun Town, Hejiang County, Bayingolin Mongol Autonomous Prefecture, Xinjiang Uygur Autonomous Region, China. Material culture and typological research at this site suggest that this site was occupied for hundreds of years. No carbon dating result for this site has been published so far. Xiaoshankou is one of the sites under the influence of Chawuhu culture. Chawuhu culture is an archaeological culture in Xinjiang which existed from the Bronze Age to the Early Iron Age. It is named after Chawuhu Cemetery in the Hejing region. Chawuhu culture lasted roughly 500 years from 1000 BCE to 500 BCE (Xinjiang Institute of Cultural Relics and Archaeology, 1990). Studies on material culture, animal remains, and dietary reconstructions suggested that ancient residents at Chawuhu probably had a nomadic lifestyle. The Chawuhu residents might expand their territory during the late Chawuhu period, and the Hejing region was probably the first region occupied and significantly influence by Chwuhu culture. Many cases of cranial perforations at Chawuhu were diagnosed as trepanation (Han et al., 2007). Would this practice spread with the expansion to the Hejing region as well?

MATERIALs and METHODS
The specimen of interest coded as 07HJXM124: A, was unearthed from a vertical stone chamber tomb that dated back to the late period of Chawuhu culture (sixth century BCE). The sex and age of the specimen were determined based on cranial traits and dental wear (Buikstra and Ubelaker, 1994; White and Folkens, 2005). Macroscopic and microscopic approaches were conducted to observe the two perforations on the skull. Three-dimension deep field microscope (KH-7700, HIROX, Japan) and CT scan (Light speed VCT, GE Company, Fairfield, USA) were applied to identify any signs of healing and additional details. The acquisition parameter of CT was 120 kV and 400mA with a slice thickness of 1.25 mm. The CT scan images were processed with RadiAnt DICOM Viewer (Version 4.6.8., Medixant, Poland).

RESULTS
The skull belonged to a male in his late adulthood, probably 45 to 65 years old. Two perforations present on his cranium: one on the left parietal bone and the other on the occipital bone (Fig.1). Both perforations presented penetrating through the inner table. They are sharply defined and are roughly oval in shape. The sizes of the two openings are similar, as the dimensions of the parietal perforation are 12.72 mm × 14.51 mm, while the dimensions of the occipital one are 11.19 mm × 14.87 mm. Fig 1 shows the close-up of the two perforations. Fig 1A shows the possible fracture line, while Fig 1B indicates the sloping margin around the occipital perforation. No apparent new bone formation could be seen around the openings. Microscopic observations (both 3D-deep field microscope and CT scan) also suggest the absence of signs of healing (Fig 2 and 3). Moreover, the 3D reconstruction images show that the endocranial defect of the two openings (Fig 4). The endocranial surface of the parietal opening presents the beveled edges, which is a typical feature of penetrating injuries (Fig 4A). This feature, however, is absent for the occipital opening.

DISCUSSION and CONCLUSION
The characteristics of the two perforations are not consistent neither with osseous reactions caused by dysotosis, parietal thinning, enlarged parietal foramen, and neoplasm nor with gnawing markers caused by carnivores. It seems plausible that the two perforations were cases of trepanation regarding the regular oval shapes and smooth margins. However, signs of tool marks are absent from the two perforations. Moreover, a sloping margin and a larger circle around the opening that often happen in trepanation cases are absent as well. On the other hand, the internal beveling and possible fracture line of the parietal opening and the ragged surface of the occipital opening are similar to the features of projectile injuries. The parietal opening is possibly the entry injury, while the exit is the occipital opening. As fo the other possibilities, details could be found at the publication of this study, Differential diagnosis of the cranial perforations on the Early Iron Age along the Ancient Silk Road in Xinjiang, China, in 2019 by the same authors.

After comparing the contemporary weapons in Xinjiang, the most likely weapon is metal-head arrows. The average diameter of metal-head arrows is 1cm, which fits the dimensions of the lesions. Admittedly, other weapons such as a spike or dagger ax could produce similar lesions. Hence, further studies on the weapons in this area are expected. As many Chawuhu trepanation cases present similar features to this case, we hereby suggest alternative explanations and further investigations for those perforations at Chawuhu, and other sites in Xinjiang as well.

This research was supported by NAP-Grant from Nanyang Technological University, Singapore, and the National Natural Science Foundation of China (No. 41572161).