



Chinese characters carry special anatomical connotations

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Received: 3 February 2024 / Accepted: 6 April 2024 / Published online: 2 May 2024
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Abstract

In the domain of anatomy, some Chinese characters in anatomical terms possess distinctive morphological significance. Chinese characters evolved from pictographic characters, with some of these pictographs being created by ancient people based on their own body structure. This implies that the comprehension and depiction of the human body structure have been integral since the inception of Chinese characters, and this knowledge has been passed down and developed through the continued inheritance of Chinese characters. Even today, certain characters retain the appearance to reflect the shape of the human body structure. By examining the characters related to vertebrae, cranial fontanel and heart, we can find the unique and enduring link between Chinese characters and the fields of anatomy as well as Chinese traditional medicine.

Keywords Chinese anatomical terms · Chinese characters · Vertebrae · Cranial fontanel · Heart

Introduction

Chinese writing, with a rich history spanning over 3,300 years (Liu et al. 2021; Chen 2008; Boltz 2003), stands as one of the oldest writings globally. The evolution of Chinese characters unfolds in the transition from intricate graphics to refined strokes, from pictograms to streamlined symbols, encapsulating a journey from complexity to simplicity. Beyond serving as the tool for conveying anatomical terms, some Chinese characters also bear unique morphological significance within the field of anatomy. This significance arises from the fact that Chinese characters originated as pictographic symbols, a creative process where ancient Chinese crafted symbolic representations based on the appearance of real-world objects. Any element has the potential to become the foundation for creating pictographic character,

and, significantly, the shape of the body structure was naturally embraced as a basis (Tang 1997). Thus, the creation and development of Chinese characters is sophisticatedly tied to the deliberate act of recognizing and describing the human body.

The ancient Chinese understanding and depiction of the human body have endured through the ages, persisting to the present day via the continued inheritance of Chinese characters. Remarkably, certain modern characters still visibly reflect some anatomical structure of the human body. From the evolution of Chinese characters, we could also see a continuous and developing exploration and depiction of the human body's structure. And the development of Chinese characters, to some extent, reflects the level of medical advancement during that particular period. Here, we analyze three representative Chinese characters alongside their corresponding structures to delve into the special anatomical connotations in Chinese characters.

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The form of the character 脊 (jǐ) visually captures the typical features of vertebrae

The Chinese character 脊 (jǐ), which means the spine, has a longstanding historical presence, dating back to the oracle bone inscription stage. In its early stage, the oracle bone script of the word resembled that of an animal skeleton, as

illustrated in Fig. 1a. And, the forms in its bronze script resembled fish skeletons (Fig. 1b, c). Despite variations in its writing form, as depicted in the figure, the expression of its shapes at this stage remains consistent, signifying the entirety of the spine and incorporating references to the ribs and other bones. This feature, which depicted the entire spine, was lost during the transition to seal script. The seal script for 脊(jǐ) presented two forms (Fig. 1d, e). Obviously both forms were more standardized, with the pictographic characteristics gradually diminishing. One form highlighted the spine and ribs (Fig. 1d). And the other had an additional bottom part (Fig. 1e), which might originate from the corresponding section in its oracle bone script. Interestingly, this bottom part in the seal script means “flesh” or “soft tissue” but shares the same written form with the character for moon either as an independent character or as part of composite characters. This alteration conveys the notion that the spine is supported by muscle tissue, applying the associative method and enriching the description of this word.

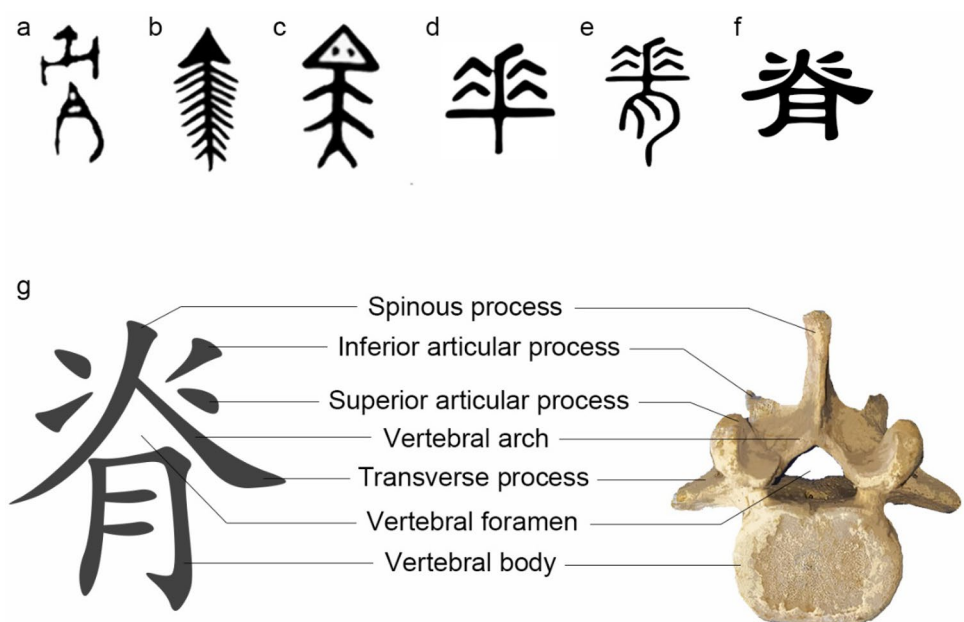
Around 2,000 years ago in Han dynasty, as the Chinese characters underwent conversion of seal script to clerical script, transitioning from lines to strokes in composition (Ying 2008; Wang 2023), a notable change occurred in the shape of 脊(jǐ) as shown in Fig. 1f. The horizontal and vertical line elements transformed into an obvious shape of character 人, and the four convex upward bends evolved into four points, losing the pictographic representation of ribs. Since this conversion, the form of this character has undergone minimal changes and remains largely consistent to the present day.

The clerical script of this character might be a deliberate alteration made by ancient Chinese individuals who were

well-acquainted with anatomy. Because, another glyph, “脊”, which better preserves its features from seal script, such as horizontal and vertical line and four convex upward bends, did not achieve widespread application and became a variant form. In terms of anatomy, the current clerical script and post-clerical script forms are simpler and remarkably accurate in portraying the structures of a single vertebra. Comparing the shape of this character with a typical vertebra, a notable correlation emerges, as depicted in Fig. 1g. A typical vertebra comprises one body, one arch, one foramen, and seven processes, including one spinous process, a pair of transverse processes, and a pair of upper and lower articular processes. Examining the components of the character 脊(jǐ), the shape of “月” aligns with the vertebral body, the “人” corresponds to the vertebral arch, and the space between “人” and “月” corresponds to the vertebral foramen. Moreover, the top point of “人” aligns with the spinous process, while the two bottom points of the “人” correspond to the transverse processes on both sides. The four points on both sides of the “人” precisely correspond to the left and right upper and lower articular processes. Consequently, the entire “脊” shape effectively projects the typical vertebra onto the horizontal plane.

The transformation of the word 脊(jǐ) from oracle bone script to clerical script marked a gradual shift from representing the entire spine to focusing on part of the spine and finally depicting a single vertebra. This Chinese character stands out as one of the few modern characters that still retain pictographic features, offering a detailed contrast with the human body structure. Certainly, ancient people did not define these seven processes on the vertebra with such precision. They may have simply observed the hole in a single

Fig. 1 **a** The oracle bone script of Chinese character “脊”. **b and c** Two forms of bronze script for the Chinese character “脊”. **d** One variant of the seal script form for the Chinese character “脊” emphasizing the vertebral column connecting with ribs. The convex upward bends represent the ribs, the vertical stroke symbolizes part of the spine, and the horizontal stroke represents the waist region. **e** Another variant of seal script form for the Chinese character “脊”. Compared to **d**, the addition of the bottom part signifies the presence of muscles supporting the vertebral column. **f** clerical script of “脊”. **g** Comparison of morphology of Chinese character “脊” and the typical vertebra



vertebra and several symmetrical protrusions on the back of the vertebra, thus adjusting character forms accordingly. It is only through our comparison of character shape and a typical vertebra that we have uncovered this corresponding relationship. Anyway, such distinctive relationships to anatomy are unique to Chinese characters developed from pictographic origins.

The Chinese character 囟(xìn) is derived from the shape of cranial fontanel

Illustrated in Fig. 2a are the evolving character forms of 囟(xìn) throughout different periods, initially appearing in oracle bone inscriptions like 囟. As a typical pictographic character in the early stages, its form depicted the superior view of the infant skull (Fig. 2b). From this view, we can observe the calvaria composing of two frontal bones and two parietal bones. During development, the calvaria undergoes intramembranous ossification. The horizontal and vertical lines in 囟 represent the membranous connective tissue between these cranial bones, which have not yet ossified. Their intersection denotes the location of the anterior fontanel. And there is still a gap between the frontal squamae, indicating

that the frontal bones have not yet fused into a single unit, as they do in the adult skull. Therefore, this character indicates the most prominent characteristic of an infant's calvaria. As a vivid pictographic character depicting the calvaria, 囟(xìn) originally meant to represent "calvaria", and later extended to mean "head".

In addition to 囟(xìn), during the oracle bone inscription period, there were two other characters closely related to the head: 首(shǒu) whose oracle bone script is 首, and

頁(yè) whose oracle bone script is 頁. The character 首(shǒu) might be created based on the side view of a single animal head, with a particular focus on the eye. Later, it gradually came to signify the entire head and has retained this meaning until now. The character, 頁(yè), was created from the side view of a person in a kneeling position, with the upper portion also prominently featuring the eye. With the evolution of Chinese characters, 頁(yè) extended various other meanings, gradually losing the original meaning of head. In modern usage, as a single character, its semantic connection with "head" has been severed completely. But there is a "頁" associated compound character 頭(tóu), which is most commonly used for "head" in modern Chinese, abbreviated as "头". As a structural part of 頭(tóu), the "頁" retains its original meaning.

As for 囟(xìn), the scope of it narrowed to denote only the membranous tissue of the cranium or meaning of "cranial fontanel" in modern Chinese and modern Chinese anatomical terminology, resulting in a reduction in its usage. But, as a constituent part of other compound Chinese characters, "囟" may represent the meaning of head. Figure 2c illustrates three commonly used compound Chinese characters composed with the component "囟". In the first character, 腦(nǎo), meaning "brain", the left part of it originally represents a person bending down. Later in the clerical script, the bending down body shape evolved into a "月" shape, which means "flesh" or "soft tissue". And the right part refers to the head, featuring the component "囟" with hairs depicted above it. Taken together, "腦", as a compound ideographic character, indicates the soft tissue organ within the head. In its simplified form "脑", "囟" transformed into an open form getting rid of the hair, which can also be easily understood as the brain, a soft tissue organ within the head. The second character, 兒(ér), meaning "infants or young children", in seal script, consists of the lower part depicting the human body and the upper part "囟", splitting in the middle, emphasizing the characteristic of an infant's unclosed fontanel. The third character, 思(sī), "meaning thinking or thought", was originally composed of "囟" and "心", but during the transition from seal script to clerical script, the form of "囟" changed to the shape of "田" for some reason.

From the analysis of the formation of these characters, it can be concluded that a complex or abstract concept can

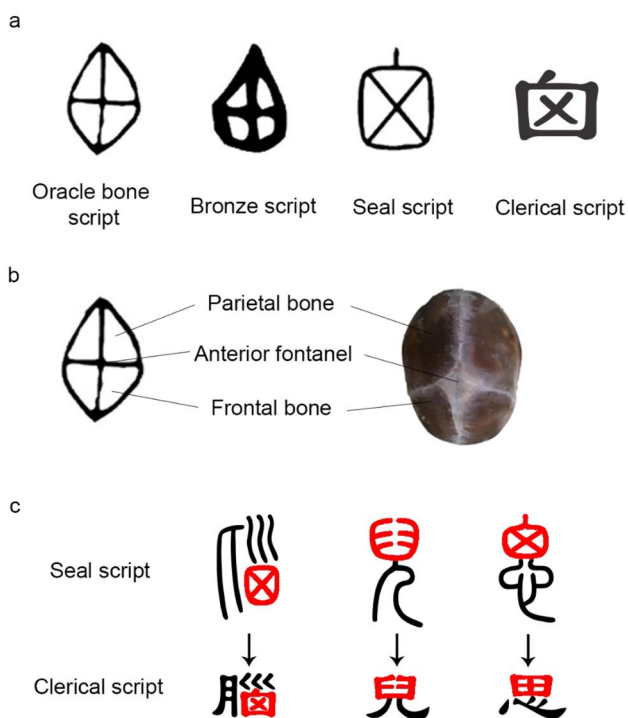


Fig. 2 a Chinese character “囟” in different periods; b comparison of the oracle bone script and the superior view of the infant skull. c “囟” as a constituent part (red part) in different Chinese characters: “腦” means brain; “兒” means young child with unclosed fontanel; “思” means thinking or thought, and the bottom part “心” means heart

be defined by a compound ideographic character which consists of several basic pictographic Chinese characters. With the reform of the Chinese writing system, this character “囟” gradually evolved into several written forms when it participated in the construction of other compound characters, as shown in Fig. 2c. Sometimes, it lost the apparent connection with the original character, 囟(xìn), itself, which led to erroneous interpretations, and in some cases, even malicious ones.

Of them all, 思(sī) is the character most easily misunderstood. This character is often criticized as evidence of the alleged backwardness of traditional Chinese culture. In its modern script form, it seemingly has no association with the head or brain, featuring only the radicals “田” and “心”, with the upper part, “田”, often loosely interpreted as another character, 田(tián), meaning farmland. While modern science recognizes that thinking or thought as a central nervous activity associated with the brain. However, upon tracing its origins, we find that ancient Chinese did not deny the relationship between this character and the brain. The origin of the misunderstanding can be traced back to the change from a circular frame to a square box in the Chinese character form.

囟(xìn), representing the head, and 心(xīn), representing the heart, were combined to form the character 思(sī). This combination conveyed a profound understanding from ancient Chinese that thinking and related mental activities involve either brain or heart. The earliest form of this word could date back to Zhou bronze inscriptions (ca. 1200–300 BC)(Chen 2008). This perspective of word-formation actually aligned with the contemporary traditional Chinese Medicine which was in the early stage of development.

The Chinese character “心” and mental activities

From character 思(sī), we can also observe a significant disparity between traditional Chinese medicine and modern medicine regarding the function of the heart. The development of the character, 心(xīn), meaning “the organ of heart”, as depicted in Fig. 3a, shows a process of evolution from concrete structure to abstract contour. The oracle bone script of the character (Fig. 3b) resembles a sectional diagram of the heart. We can observe that the glyph portrays outlines resembling the heart chamber and valves. The upper chamber represents atrium and the lower one means ventricle, with valves between them surrounding the atrioventricular orifice. Clearly, from the inception of this character creation, there was a clear reference to the concept of the heart as an organ, which aligns with modern anatomical definition. Above all, Chinese

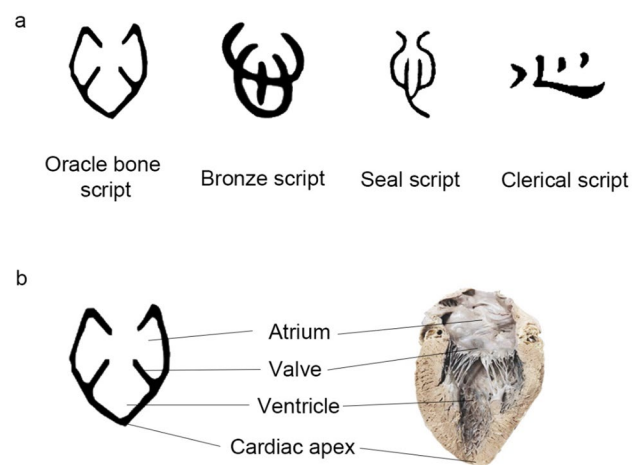


Fig. 3 **a** Chinese character “心” in different periods; **b** comparison of morphology of Chinese character “心” in oracle bone script with the section of a heart specimen

traditional medical knowledge about the heart’s function was evidently based on this anatomical foundation. With further understanding, people had developed a broader comprehension of the heart’s functions, proposing that the heart, beyond its circulatory function, plays a pivotal role in leading mental activities. In fact, a similar notion existed in early Western medicine as well, albeit with less detailed elaboration and less proofs. Ancient Chinese medical texts, including the *Huang di nei jing*, provided more explicit and detailed discussions on this matter, serving as the basis for developing treatment methods for related mental diseases.

While this may seem antiquated or even ridiculous to modern science, an increasing number of contemporary scientific findings seem to lend support to this ancient theory. Noteworthy evidence includes personality changes observed in heart transplant patients(Bunzel et al. 1992). Despite hypotheses such as post-traumatic stress syndrome and cellular memory, there is a lack of substantial proof(Liester 2020). Research in cardiac endocrinology demonstrates a significant correlation between brain natriuretic peptide (BNP), mainly secreted by the heart, and cognitive dysfunction in the brain(Hurk et al. 2011). Numerous clinical studies have illustrated a significant correlation between heart failure and cognitive impairment (Cannon et al. 2017). These findings bolster the ancient theory that designates the heart as the controller of mental activities. At the very least, the idea that the heart could influence the mind is difficult to be denied. The ancients’ understanding, perhaps not as outdated or inaccurate as it may seem, provides a valuable perspective that should not be hastily dismissed. It can serve as an inspiration for our modern research.

Conclusion

Chinese characters like 脊(jǐ), 囟(xìn), 心(xīn) in anatomical terms expand the meaning of language for *human anatomy*, particularly for its morphological context, and enrich connotations of Chinese culture. We can observe the ancients' advanced understanding of the structure and physiology of the human body through these characters. It not only captures the ancient people's depictions of the human body but also mirrors their thinking about human body. In a way, it serves as a unique connection between natural science and human science. It really stands as the precious wealth left to us by our ancestors.

Funding This article was funded by the following projects: 1. Resource construction project of postgraduate education in Nanjing Medical University (2023C001); 2. Curriculum construction project of Tianyuan Class of Nanjing Medical University; 3. The first batch of ideological and political demonstration courses in Jiangsu Province's universities - Human Anatomy (Su Jiao Ban Gao Han [2021] No.11); 4. The first batch of ideological and political demonstration course projects at Nanjing Medical University (JX10131720190503).

Declarations

Conflict of interest The authors declare that they have no conflicts of interest.

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