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Human Anatomy in ancient Indian sculptures of Gandhara art illustrating the fasting Buddha

Sreenivasulu Reddy Mogali[1], Peter Abrahams[1,2]

[1]Lee Kong Chian School of Medicine, Nanyang Technological University, Singapore , [2]Warwick Medical School, The University of Warwick, United Kingdom

SUMMARY

The present article intends to report the surface anatomical features in the three fasting Buddha sculptures and also tries to understand the anatomical knowledge of these ancient Indian sculptors by observing the digital images of the sculptures of the Gandhara art depicting the fasting Buddha. Close examination of the colour 2D digital photographs of the fasting Buddha which are available freely at Google Cultural Institute, the British Museum and the Metropolitan Museum web portals.

Our observations demonstrate that the bones and joints of the thoracic cage, pectoral girdle, the extremities, particularly the upper limb, the skull and the pelvis were distinctly shown in the sculptures. Muscles of the neck (sternocleidomastoid, trapezius), shoulder (deltoid), thoracic cage (pectoralis major), limbs (arm and forearm), and anterior abdominal wall were clearly carved into the sculptures. The trachea was correctly placed in the neck. The boundaries of the axilla, and triangles of the neck were also clearly seen.

Our observations demonstrate that ancient Indian artists of the Gandhara region had a basic knowledge of human anatomy, especially surface anatomy and musculoskeletal features. They also possessed knowledge of the approximate size and position of the bones, joints and muscles, including their approximate origin and insertion points. However, certain errors of anatomical knowledge including an extra number of ribs and a segmented sternum were noticed. Further, they also seemed to have some basic ideas about the physiological changes that occur during starving, as it is evident in the Buddha sculptures, which are skinny and emaciated.

Key words: Ancient India – Fasting Buddha – Sculptures – History of anatomy – Gandhara art

INTRODUCTION

Siddhartha Gautama was the founder of Buddhism. A royal prince in ancient India, now located in Nepal, he left his palace in search of enlightenment. He meditated and fasted for 49 days and nights at the base of the Bodhi tree, in Buddha Gaya (now in North-eastern India) in order to attain enlightenment. From then on, Siddhartha Gautama was known as the Buddha - "The enlightened one" (Arnold, 1879; Trainor, 2004; Pandey et al., 2015). The ancient Indian sculptors of the Kushan dynasty, Gandhara region, carved for the first time a stone sculpture of the fasting Buddha in the 2nd or 3rd century AD (Rengel, 2004). Sculptors depict the fasting Buddha seated in a meditation pose as in an emaciated state, with the body reduced to a frame of skeleton. This is famously known as the statue of Fasting Buddha (Siddhartha), as illustrated in Fig. 1, which is currently housed in the Lahore Museum (Lahore, Pakistan). This sculpture of the Buddha ranks not only as a famous example of Gandhara art, but also as one of the rarest antiquities from this period of ancient history. In addition, the sculpture of Fasting Buddha Shakyamuni (Fig. 2) and the Schist head of the Fasting Buddha (Fig.

Corresponding author: Dr Sreenivasulu Reddy Mogali. Assistant Professor and Head of Anatomy, Lee Kong Chian School of Medicine, Nanyang Technological University, Singapore, 636921. Phone: +65 6592 3114.

E-mail: sreenivasulu.reddy@ntu.edu.sg

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3), (Metropolitan Museum of Art, New York, British Museum respectively) were also recognised as some of the very best examples of Gandhara art.

In 1973, Murthy reported on the artist's anatomical knowledge using black and white photos of the sculpture of the Fasting Buddha (Fig. 1).The anatomical features reported were solely based on the examination of a two-dimensional (2D) picture (Murthy, 1973). Considering the technological limitations of the photography in 1970's, it is often difficult to see all the details based on observation of the 2D black-and-white pictures of the sculptures. Over the years, considerable advancements in digital photography have made it now possible to observe intricate details carved in the sculptures. The present article reports surface anatomical features in the fasting Buddha sculptures, and also tries to understand the anatomical knowledge of these ancient Indian sculptors by observing the digital images of the sculptures of the Gandhara art depicting the fasting Buddha. In addition to the digital image of the Buddha (Fig. 1), we also examined two more digital images of the fasting Buddha of Gandhara from this period (Figs. 2 and 3) which are now freely available online at the Google Cultural institute (Figs. 1 and 2) and the Metropolitan Museum of Art (Fig. 3). Our observations of the digital images of the sculptures were compared and contrasted with the previous observations from old photos (Murthy, 1973).

MATERIALS AND METHODS

Methodology involved close examination of the colour 2D digital photographs of the fasting Buddha (Figs. 1, 2, & 3) which are available freely online. Two of the three sculptures (Figs. 1 and 3) are available at the Google portal (Google Cultural Institute) https://www.google.com/culturalinstitute/asset-viewer/fasting-siddhartha/QgGcgQazjovxxg?hl=en. This portal offers digital pictures with zoom in and out facility, which facilitated our better observation on detailed anatomical features. The third sculpture (fig. 2) is available on the following website http://www.metmuseum.org/art/collection/search/38119.

RESULTS

Following are surface anatomical features found in the photos of the sculpture of the fasting Buddha.

Anatomical features in Fig 1: The observations on the sculpture indicate that this artist depicted the Buddha as a yogic ascetic, seated in a meditating pose, and showed him as a skinny and emaciated person due to his fasting for 49 days. The base of the sculpture shows a scene representing his disciples praying for him. Surface anatomical features of this sculpture are individually described below.

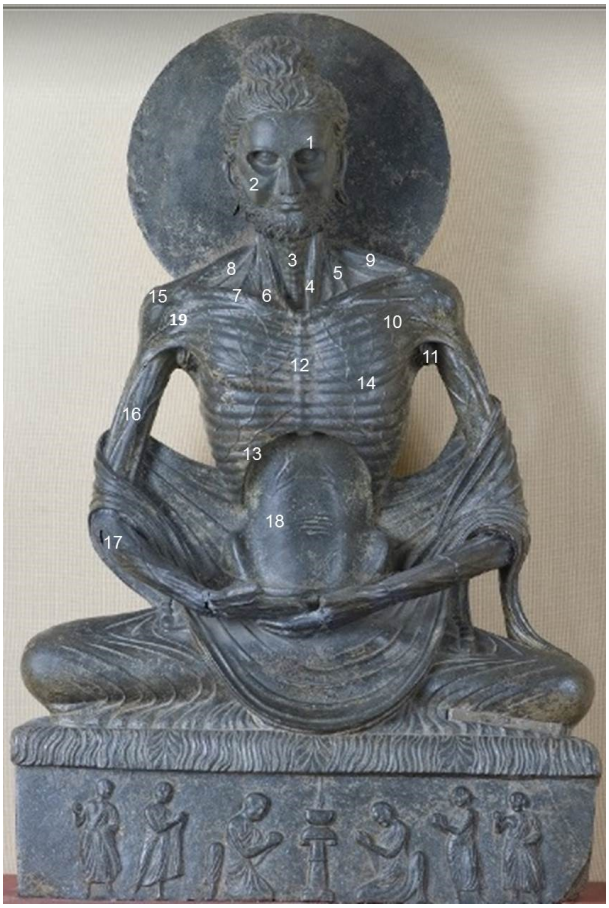

Fig 1. The fasting Siddhartha (Buddha). This sculpture belongs to the 2nd or 3rd century AD (from Lahore Museum, Pakistan). 1=orbital margin; 2=maxilla; 3=trachea; 4=sternocleidomastoid; 5=external jugular vein; 6=supraclavicular fossa; 7=clavicle; 8=brachial plexus; 9=trapezius;10=pectoralis major; 11=axilla; 12=sternum (segmented body); 13=costal margin; 14=ribs; 15=deltoid; 16=biceps brachii; 17=superficial extensor muscles of forearm; 18=rectus abdominis; 19=cephalic vein.

Clavicles are placed in almost a horizontal position with correct articulation medially with the manubrium sternum, and laterally with the acromion process.

There are a total of 17 pairs of ribs, out of which upper 10 pairs articulate with the sternum directly and the rest are free anteriorly.

The sternum appears clearly in the midline, and its three components are depicted: manubrium, body and xiphoid process. The body is noted to have numerous segments.

The picture clearly shows the *pectoralis major* muscle with its correct origin and insertion.

It also illustrates the deltoid muscle with its rough origin and insertion. The rounded shoulder contour gives an impression of bony landmarks (head of humerus) under the deltoid muscle.

Anterior and posterior axillary folds are clearly demarcated. The armpit (axilla) is shown promi-

nently between the axillary folds.

Prominent superficial veins of the forehead, upper limb, thoracic wall and anterior abdominal wall were observed.

The anterior superior iliac spine, the iliac fossa and the iliac crest are distinctly shown.

An impression of the external jugular vein is anatomically and correctly shown in the neck.

The picture also shows two heads of the sternocleidomastoid muscle (SCM) with the supraclavicular fossa between the two heads of the SCM.

The boundaries of the posterior and anterior triangles of the neck can be clearly seen.

The impression of the brachial plexus is shown in the posterior triangle.

Gross impression of the flexor and extensor muscles of the arm and forearm are visible. Even some separate forearm tendons are identifiable.

The cephalic vein is easily seen bilaterally in the delto-pectoral groove.

A compressed anterior abdominal wall was observed with three redundant skin folds at the umbilical region.

The trachea appears to be in the midline of the neck and exhibits numerous tracheal rings.

The umbilicus is shown in the midline and four small transverse skin folds imply weight loss across the abdomen.

Anatomical features in Fig. 2:

This sculpture shows the body of a fasting Buddha seated in meditating pose. However, the head portion is missing. The Buddha was shown as a thin body reduced to a skeletal framework, especially in the thoracic region with compression and a sucked-in anterior abdominal wall. However, the musculoskeletal features in the limbs are not evident. The base of the sculpture shows a scene that could be Buddha's first sermon. The following surface anatomical features were noticed on this sculpture.

There were twelve pairs of ribs, out of which the upper seven ribs are directly articulating with the sternum and lower 5 ribs are free anteriorly.

The sternum is in the midline and its body appears as two snakes interwinding around like a caduceus — a medical symbol from ancient times and associated with Hermes. This has been often linked to Alchemy and by the 15th century to medicine.

The clavicles are placed obliquely and articulate medially with the sternum and laterally to the shoulder region, but the lateral articulation appears to be anatomically inaccurate.

The anterior abdominal wall is compressed and sucked-in antero-posteriorly.

There are impressions of intercostal spaces between the ribs.

Numerous blood vessels are emerging from the intercostal spaces onto the anterolateral thoracic wall.

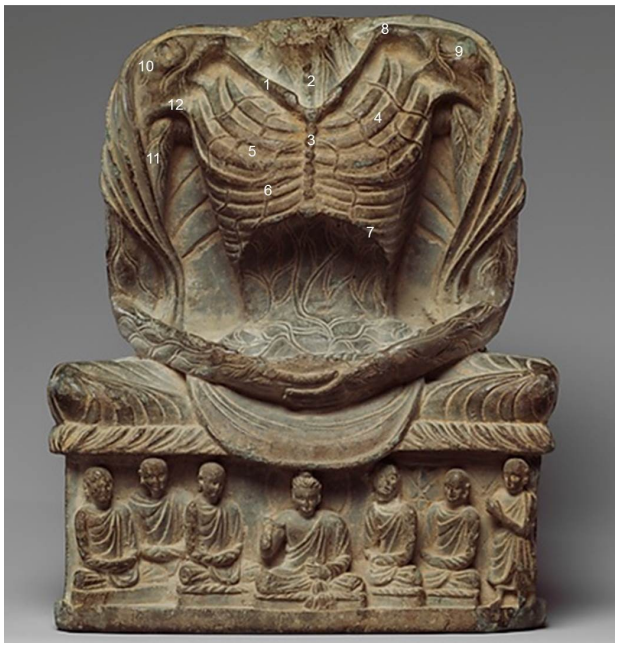

Fig 2. The fasting Buddha Shakyamuni, 3rd-5th century, Kushan period, Pakistan/ancient region of Gandhara (from Metropolitan Museum of Art). 1=clavicle; 2=trachea; 3=sternum (appears as two snakes winding around like a caduceus); 4=rib; 5=intercostal space; 6=subcutaneous blood vessels; 7=costal margin; 8=acromioclavicular joint; 9= head of humerus; 10=deltoid; 11= biceps brachii; 12=anterior axillary fold.

Anterior and posterior axillary folds were clearly shown.

Both upper and lower limbs appear as thick, ill-defined blocks of stone with no obvious musculoskeletal features.

The trachea exhibits a segmented pattern in the midline of the neck.

Anatomical features in Fig. 3:

This sculpture is showing only the head portion of Buddha's body. Note that the body is missing and the nose and left ear have been destroyed. This sculpture mainly shows bony prominences in the facial region and muscles of the neck and upper respiratory tract. The anatomical features of this sculpture are explained below:

Prominent orbital margins and sunken eyes are evident.

Prominent zygomatic and maxilla bones are easily appreciated.

Hollow cheeks and chin are clearly seen.

The angle of the mandible and its inferior margin is obvious.

The trachea is shown as segmented structures in the midline of the neck.

Laryngeal cartilages, especially the cricoid cartilage, is shown above the trachea.

The two heads of SCM are clearly depicted.

Thick scalp hair but no facial hair is sculptured.

The forehead has a V-shaped supraorbital dilat-

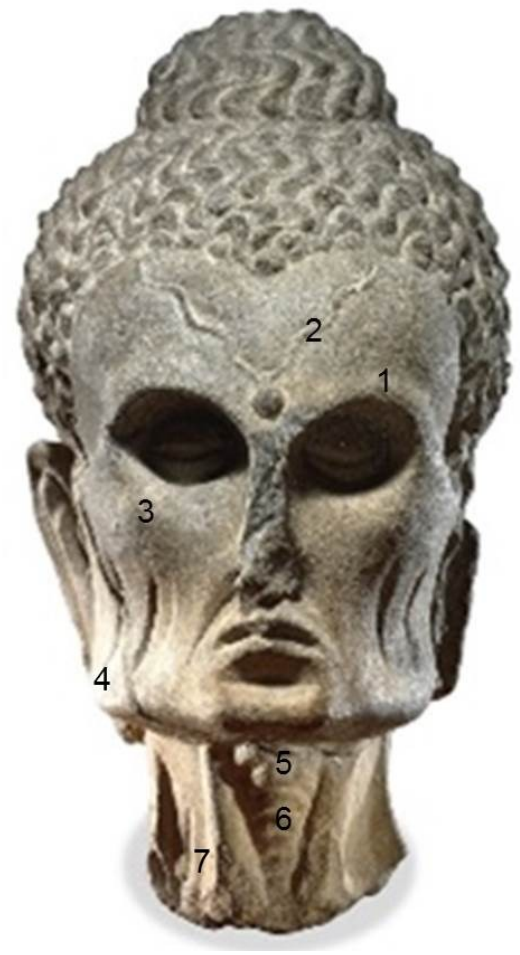

Fig 3. Schist head of the fasting Buddha (date created 100 AD - 299 AD). This sculpture is available in the British Museum (http://www.britishmuseum.org/research/collection_online/collection_object_details.aspx?objectId=225168&partId=1). 1=orbital margin; 2= V-shaped superficial vein; 3=maxilla; 4=angle of mandible; 5=laryngeal cartilages; 6=trachea; 7=sternocleidomastoid.

ed vein.

DISCUSSION

According to the available information, Buddha meditated and fasted for 49 days beneath the Bodhi tree in Bodhgaya "(Arnold, 1879; Trainor, 2004; Pandey et al., 2015). Artists in Gandhara carved the sculpture of the fasting Buddha to depict his emaciated state. In this article, we discuss the artists' knowledge of the human anatomy presented in the sculptures. The thoracic cage is barrel-shaped in both Figs. 1 and 2, i.e. expanded anteriorly and laterally a distinctive feature of humans. The sternum is in the midline with its three components — i.e., manubrium, body and xiphoid process. However, the body of the sternum was sculpted to have numerous small segments in Fig. 1, and two interwinding snakes in Fig. 2, neither of which is a feature of humans! In Fig. 1, the extra ribs oriented horizontally without angulation are sculpted, whereas the correct number of ribs are shown with accurate anatomical orientation in Fig. 2. This indicates that the sculptors had an idea of the components of the thoracic skeleton and how it is placed within the body, but had limited knowledge of the structure of the human sternum, or the number of ribs and their exact orientation. The sculptor depicted a segmented sternum, and additional ribs in the sculpture (Fig. 1). It is quite possible that artists in ancient times observed the animal skeletons and transposed that knowledge while carving human sculptures. For example, monkeys do have a segmented sternum (Aiello and Dean, 2002) and the horse has mostly 18 ribs (Budras et al., 2004). It is interesting to note that even the famous Renaissance scientist Leonardo da Vinci some 1200 years later in his magnificent anatomical drawings seen in Windsor castle, UK, made the same mistake, probably by copying Galen's error (Clayton and Philo, 2012).

The previous paper (Murthy, 1973) reported that no xiphoid process and manubrium is seen in the sculpture (Fig.1). However, the xiphoid process is clearly seen in the magnified digital colour picture. We understand about this missed observation in the previous paper, which was made solely on poor quality black and white images. The artist has shown dilated subcutaneous blood vessels on the anterior thoracic wall (Figs. 1 and 2). They were shown emerging from the intercostal spaces. Intercostal spaces were shown as impressions between the ribs. This indicates that the artist had some reasonable idea about the intercostal spaces and blood vessels in the thoracic region (Murthy, 1973).

The anterior abdominal wall was flat and appears to be highly compressed antero-posteriorly with no subcutaneous fat (Figs. 1 and 2). This indicates the artist's knowledge of the basic physiological changes in the body during prolonged fasting. However, prominent dilated blood vessels in the prolonged fasting state are not consistent, as the blood pressure falls in chronic fasting (Murthy, 1973). The anterior abdominal wall had two longitudinal elevations with a slight convex lateral border lying on each side of the median plane (Fig. 1). These elevations are most likely to be the rectus abdominis muscles. However, no digitations — i.e., tendinous intersections — were shown in this *rectus abdominis* muscle. The umbilicus was shown in the midline and four small transverse folds were depicted at the umbilical region (Fig1), but the umbilicus was not shown in Fig. 2.

A rounded shoulder contour is well illustrated by the deltoid muscle. A prominent acromioclavicular joint and head of humerus are also well depicted (Figs. 1 and 2). Upper-limb musculature (arm and forearm) appears to be moderately sized, which is consistent with chronic starving (Fig. 1). However,

Fig. 2 shows thick limbs that are not consistent with chronic starving. The sculptures also clearly indicate the *pectoralis major* muscles, forearm muscles, and tendons, also the anterior and posterior axillary folds of axilla (Fig. 1). A lump-like feature in the axilla (Fig. 1) is noted that is most likely representing the axillary hair which was not reported earlier (Murthy, 1973). This indicates that ancient artists had awareness about bones, muscles, tendons and their positions in the limbs including their rough origin and insertion points.

Sternal and clavicular heads of the SCM were clearly illustrated and shown anatomically correctly (Figs. 1 and 3). The deep fossa between the two heads of SCM is shown, presently known as supraclavicular fossa, which is a landmark to access the internal jugular vein for central venous line insertion (Boon et al., 2007; Kim et al., 2014).

Boundaries of the posterior triangle (SCM anteriorly, trapezius posteriorly and clavicle below) of the neck are well shown (Fig. 1). A slender elevation passing from the angle of the mandible towards the clavicle is shown, which is possibly the external jugular vein. A similar elevation is shown in the posterior triangle, possibly to depict the trunks of the brachial plexus (Fig. 1). These observations are not reported in the earlier report (Murthy, 1973). The trachea is shown prominently in the midline of the neck as a somewhat tubular structure, having several segments to indicate tracheal rings in all three sculptures. The upper two segments of the trachea appear more prominently than others and are most likely to indicate the laryngeal prominence or laryngeal cartilages (Fig. 3). This indicates that the artist had some knowledge of larynx and trachea position, their basic structure and course.

The eyes have been shrunken and orbital margins shown prominently, which is quite similar to the chronic starving state. However, eyebrows were not shown. The maxilla and zygomatic bones were shown very prominently and the cheeks appear to be hollowed (Figs.1 and 3). This is well consistent with the starving state, as the buccal pad of fat will be utilised during chronic starvation. However, the previous report mentioned that cheeks have been shown very prominently, which is in contrast with the starving condition (Murthy, 1973). We think that the facial hair in the black and white photograph used in the earlier report (Fig. 1) might have given the prominent appearance to the cheeks. On closer examination, the moustache and beard are beautifully defined with long curly tufts of hair (Fig. 1). The author also mentioned that facial expression of the Fasting Buddha corresponds to the facial expression of a starving person (Murthy, 1973). However, our observations indicate that the face of the Fasting Buddha did appear as an emaciated, pale, attenuated body, wrinkled and skinny as in aged persons, and these features are consistent with a state of starvation.

Conclusion: From these observations, we believe that the ancient Indian artists of the Gandhara region had some basic knowledge of human anatomy, especially surface anatomy and musculoskeletal features. They possessed the knowledge of the approximate size and position of the bones, joints and muscles, including their approximate insertion points. However, they lacked the accurate details of individual bones — i.e., number of ribs and structure of the sternum. Furthermore, they also seemed to have a basic idea about the physiological changes that occur during starvation, as shown by the Buddha sculpture's skinny and emaciated features.

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