Ali Kosh Lady and her Artificially Modified Head: An Appraisal

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We had the opportunity to examine the cranium of a young woman found at the well-known Neolithic site of Ali Kosh on the Deh Luran plain in southwestern Iran. It has previously been claimed that her head shows traces of modification, a practice which can be termed as either cultural or artificial cranial modification. Here, we describe several macroscopic characteristics of the modified crania and discuss how this claim can be dismissed. Our craniometric study of the Ali Kosh cranium showed that the morphological state of that cranium is analogous to that of the crania of modern humans. A comparison of the morphological change patterns of deformed crania and development of wormian bones with that of Ali Kosh suggest that the Ali Kosh cranium is not the result of artificial head deformations.

Keywords: *Artificial or cultural modifications; Ali Kosh cranium; Cranial morphological change; Wormian bones*

Introduction

The term "artificial or cultural modification" is used to describe practices which alter the shape of the cranium in infancy and early childhood. Since during the early years of life, the skulls are quite malleable (Blom 2005), a desired shape can eventually be created through manipulation. Most cultural deformational procedures begin within the first few days of life, and the deforming apparatus is used for approximately six months to one year, though in some societies, such as those of Ecuador and Peru, may employ this process for as long as three to five years (Torres-Rouff 2002). Although it is possible for both genders to be the subject of cranial modification, the frequencies vary among societies. Cranial modification is induced in many ways, depending on which method is in use.

Studies show that two methods have been commonly in: 1) Annular form: in this way, the anterior and posterior of the head is extended and lengthened by wrapping bandages or by a tight hat, producing a cylindrical or conical head shape. Such an extension influences the frontal, temporal, parietal and occipital bones and creates cranial tapering on both sides. 2) Tabular forms: this involves a more directed pressure resulting from the use of boards or stiff pads on the anterior and posterior of the skull, making it wide and short in form. This limitation also influences ordinary curvature of anterior and posterior sides and forces the parietal bone to expand. Tabular form may appear in two shapes, according to the angle of direct pressure on the posterior side. For erect forms, the plane of pressure is perpendicular to the base of the head, while in oblique forms, the plane of pressure parallels that on the frontal bone AT a 45º angle from the base of the head. (Torres-Rouff 2002: 167)

Morphological modifications of crania depend on scale and duration of compression. Many modified crania have been made through combining various techniques and tools employed. Using secondary bandages leads to bone furrows such as the sagittal groove, which divides the upper part of the crania into a right and left hemisphere. Growth vectors of the skulls are generally reflected by the shape of the crania during and after the practice rather than by the compression vectors themselves. For instance, post-bregmatic and supra-lambdic furrows express the direction of sutural growth vectors once the fontanelles are obliterated (Ricci et al. 2008). A kind of cranial modification is observable in some societies which is neither intentional nor purposeful, as when an infant was secured on a cradle board for a long time, whereby those portions of the head in direct contact with the board would be flattened (Daems and Croucher 2007: 3).

There are numerous reasons for artificial cranial modification among different ethnic groups or different social communities. However, it seems that cultural beliefs can constitute a foundation for

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this kind of practice. Among some cultures of the Latin America, such as those of Chile, Colombia, and Peru, this practice was thought to play a factor in men's power and courage. Some other cultures hold molded crania as a mark of the status and personality of high-class persons. Among peoples of the northwestern coasts of southern America, slaves were not allowed to modify their crania themselves. Therefore, cranial modifications indicated their social positions (O'Loughlin 2004: 147).

Expressing social differences by those individuals trying to emphasize their distinctiveness through the use of unique headshape has a long precedent among ancient societies (Blom 1999: 10). Although cranial modification is a biological occurence, where the purpose of head shaping expresses ideas and symbols as a component of the action of scoiety, these modifications sometimes had bodily effects, yet in other cases left the body without any structural change. Nevertheless, in all cases these phenomena are raised according to an attitude in which the body is perceived as a symbol of the society (Synnot 1993: 4) or as a diagnosis of societal identity (Molleson and Campbell 1995: 52; Jones 2004). Torres-Rouff and Yablonsky (2005) reported types of modification practiced by Eurasians for political adaptations. Head shape was altered from the occipital to the circular type according to the Huns' power structure.

The oldest known evidence of head modification was discovered at the Zhou-Kou-Tien cave in China, and has been dated to between 23000-18000 BC of the Upper Paleolithic era (Soto-Heim 1986). In the Near East, the tradition can be traced as far back as to the Neanderthals of the Shanidar cave in Iraqi Kurdistan (Trinkaus 1982). The most important Near Eastern cranial modifications are those from Neolithic sites in Jericho (Palestine), Ganj Dareh, Ghenil Tepe, Ali Kosh, Chagha Sefid (Iran), and Khiro-Kitiral (Cyprus). Some well-known Chalcolithic sites at which modified crania have been discovered are Sehgabi (Iran), Eridu (Iraq), Byblos (Lebanon), Ain Jebrud (Jordan), Seyh Hoyuk, Kurban Hoyuk, Bakla Tepe, and recently Deĝirmentepe (Turkey) (Deams and Croucher 2007; Meiklejohn et al. 1992; Hours et al. 1994).

Furthermore, some of the Bronze Age sites of the Near East have also yielded evidence of modified crania, the most important of which are: Enkomi (Cyprus), Hayas Hoyuk, Adiyaman (Turkey), Lachish (Palestine) (Özbek 2001; Meiklejohn et al. 1992). The tradition of cranial modification also found in some regions of eastern Eurasia, such as southern Turkmenistan, Chorasmia and Tajikistan extending to the Caspian and Black seas (Torres-Rouff and Yablonsky 2005). Some of them are later than the samples of the Near Eastern regions and have been dated between the Bronze and the Later Iron Ages. In the Near East, cranial modification has probably continued until very recent times. It seems that some tribes of Caspian and Black Sea coastal areas have continued it from earlier times to the present. This practice has also been seen among the Yuruk tribe of southern Turkey (Özbek 2001: 238). Daems and Croucher (2007: 15) have indicated many examples of recent use of cranial modification in the Near East where the tradition was applied until the first half of the last entury, such as those villages of Bahsany and Bashiqa near the Jebel Sinjar and among the Kurdish population of Shanidar region in Iraq and those peoples of Armenia as well as Hindu communities in Baluchistan.

This paper deals with a female cranium referred here to as "Ali Kosh lady," now stored at the Iranian National Museum. Ali Kosh is a well-known Neolithic site located in the Deh Luran plain and has been systematically excavated by Frank Hole and his colleagues in 1961 and 1963 (Hole et al. 1969). From its earliest layer (eighth millenium BC) which is known as "Ali Kosh phase- Zone B2," 13 child and adult skeletons were found under the residential floors. Three of them (burials 33, 34 and 34a) were female, and all represented cranial modifications (Hole et al. 1969: 248). At least six additional skeletons were found from "Chagha Sefid" (seventh to sixth millennium BC), another Neolithic site of the Deh Luran plain (e.g. burial No. 5 of Zone A4), all of which were claimed to display artificial deformations on their crania (Hole 1977: 344-345). The crania of Ali Kosh lady was very badly preserved and also was crushed at the time of its revealing.

No further analysis has been made to identify its original shape, but its presence within this deformed context led Hole to suggest this cranium as the artificially modified type. Since then, the Ali Kosh lady's cranium has been used as a reference to prove existence of artificial cranial modification processes in Neolithic Iran (see for example: Daems and Croucher, 2007). According to the metric analysis we conducted in 2007, we found that though the Ali Kosh lady's crania has visually showed some degree of deformation, we believe that its deformation has been due to post-burial and natural formation processes and that it is anatomically different from those which were deliberately modified.

Morphological Change Patterns of the Deformed Crania

In anatomical terms, the cranial deformation types include those described by O'Loughlin (2004: 148), such as occipital deformation, lambdoid deformation, fronto-vertico-occipital, parallelo-fronto-occipital, and annular deformation. Occipital deformation leads to flattening of the nuchal portion of the occipital bone. The deformation of the lambdoid is resulted in flattening of the crania around the lambda. Fronto-vertico-occipital results in flattening of the upper part of the occipital bone, as well as an oblique flattening of the frontal bone. Frontal and occipital areas are flattened as a result of parallelo-fronto-occipital deformation. With this kind of deformation the occipital bone deforms obliquely, whereby the occipital and frontal bones take a parallel form to each other. The upper part of the crania takes a cylindrical form as a result of pressure in annual deformation and it becomes ovoid (fig. 1).

Far from the common criteria for anatomical changes mentioned above, it is possible for each cranium to have special morphologic changes depending on the kind of technique operated and the duration of compression applied. Cranial modification is sometimes practiced by wrapping a band around the head or sometimes by using two bandages diagonally. Each technique has a particular effect on cranial morphology. Lambert (1979), for instance, has determined three morphological modifications on Ganj Dareh crania which had been deformed annularly:

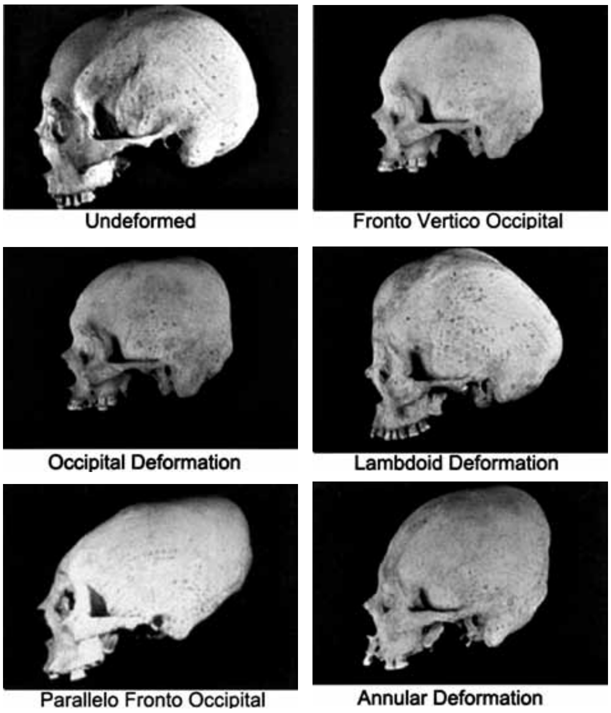

Fig.1: *Cranial types mentioned in the text (After: O'Loughlin 2004, fig.1)*

1) Crania with post-coronal depression, which was positioned on both parietals and slightly posterior to the coronal suture.

2) Crania with a parietal bulge, an elevated area of bone positioned on the posterior of the postcoronal depression and parallel to it.

3) Crania with lambdoid flattening, which can be defined as a flattened area just above the lambda.

As Lambert has mentioned, morphological modifications of the post-coronal depression and parietal convexity resulted from a band running over the point bregma and under the mandible. Lambdoid flattening also resulted from applying two bandages diagonally placed, running from the front of the head along the sides of the cranium and wrapped strongly behind the occipital. Meiklejohn and his colleagues (1992: 89) realized three other morphological changes in crania through their analysis carried out on the data recovered from Ganj Dareh, Ghenil Tepe (Iran) and Douqras (Syria).

1) Horizontal grooving or parieto-temporal grooving resulted in a depression the on squamosal suture, completely observable from the

posterior view. This depression was made using a secondary bandage which flattened the lambdoid.

2) Occipital grooving is a depression which begins at the occipital bone and then continues at a right angle to the sagittal suture. This position is achieved using diagonal bandages.

3) Porosis or hyperostosis is the third characteristic of deformed crania, resulting from bandaging which may cause porosis of the skull vaults.

Özbek (2001) revealed such morphological deformations on crania discovered from a Chalcolithic site of Deĝirmentepe, Turkey (latter half of the fifth millennium BC). There have been found 31 crania belonging to sub-adults of which all infants and children were buried in cylindrical ceramic pots. He observed that artificial cranial modifications were achieved here using single or double bandaging to obtain a desired crania shape. Secondary bandaging was used in childhood to shape a desired cranium. Here, a secondary bandage passed just posterior to the coronal suture, surrounding the head transversally and supported by the mandible. In the area between the first pre-bregmatic bandage and the second postbregmatic bandage a visible bulge developed.

Özbek's studies show that at Deĝirmentepe the desired deformation types of crania was age-related; for example, infants under one year old all display prebregmatic frontal flattening resulting from the application of a single band. The depression caused by the vertical band in the postbregmatic region becomes visible only among those who are over one year old.

Recently, Ricci et al (2008) have comprehensively analyzed a series of deformed crania discovered from the Wadi Tanezzuft in Libya, dated to the later periods of pastoralism (about 2300 BC). They produced drawings illustrating the morphologically changed pattern of crania affected by deliberate deformation processes (fig. 2). As can be seen from the figure, there are modifications recognizable on the inferior and posterior parts of the vault, including 1) a noticeable coronal postbregmatic depression (a) as the secondary effect caused by compressions acting anteriorly (a) and posteriorly (c, d), and b) a marked depression immediately above the lambda affecting mid-sagittal contour (c), resulting in an interparietal plane which covers nearly half of the sagittal suture. This plane is extended laterally and runs parallel to the lambdoid suture (d). This position leads to an occipital swelling and backward protrusion of occipital squama, shaped as a marked posterior bunning (e). More importantly, one of the marked morphological modifications realized by Ricci et al. (2008) is a distinct depression interposed between the inferior and posterior nuchal lines.

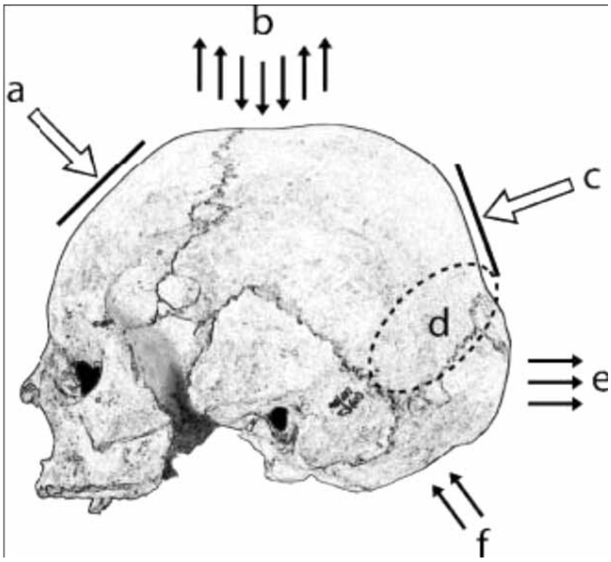

Fig. 2: *Morphological changes of crania under the artificial deformation processes (a to e) discussed in the text. (After: Ricci et al. 2008, Figure 3)*

Development of Wormian Bones in the Modified Crania

Wormian bones - or in other words, sutural, supernumerary ossicles - are unshaped irregular bones which appeared from independent ossification processes along cranial suture lines and fontanelles. There are many references in physical anthropology to the influence of artificial pressures on crania leading to wormaian bone incidences (see: Anton 1989; O'Loughlin 2000, 2004; Ricci et al. 2008). The formation and incidence of wormian bones along the lambdoid suture, for instance, may be the result of a strong genetic factor, while its degrees of variance are always under the influence of cultural modifications (El-Najjar and Dawson 1977).

This statement is also clear in White's discussions. He has proposed that there is a positive association between fronto-occipital deformation and the appearance of lambdoid ossicles, so that this practice has a direct effect on increased sutural complexities in the lambdoid area, but an indirect effect on the frequency of labdoid Wormian bones (White 1996). Furthermore, different techniques of modification and the appearance of Wormian bones with their frequency are somehow interconnected. For example, as Anton et al. (1992) pointed out, unmodified crania show more Wormian bones than circumferentially modified crania, but anteroposteriorly deformed crania displayed more Wormian bones than un-deformed crania. O'Loughlin (2004: 152) recently reported his comparative study on the data of 127 modified and unmodified crania from the New World archaeological sites. He realized a positive relationship between artificial cranial modification and the frequency of certain types of Wormian bones along the main sutural areas. He stated that the Wormian bone frequencies may increase or decrease, depending on the types and degree of cranial deformation and the location of Wormian bones. For example, lambdoid and occipital deformed crania exhibited higher frequency of lambdoid, coronal and apical Wormian bones than did the un-deformed crania. The same is correct for the parallelo-fronto-occipital and annular deformed types which displayed higher frequencies of coronal, pterionic, apical, squamosal and lambdoid Wormian bones than the un-deformed types. Meanwhile, the fronto-occipital types exhibited lower frequencies of coronal and pterionic Wormian bones, but much higher frequencies of almost all of the posteriorly placed Wormian bones (see fig. 1 for different types of deformation).

The relation between artificial cranial modification and Wormian bones also has been clearly expressed in recent studies of Ricci et al. (2008), which have been conducted on the deformed crania of southwestern Libya. They have concluded that the incidence and frequency of Wormian bones is affected extremely by ontogenetic stressors. Some sources of those stressors may be internal, such as muscular development, brain expansion, craniostenosis, or factors of bone development, or external, such as environmental factors (i.e. bandaging) which are capable of causing a hypostotic reaction of the bony tissues.

In order to understand the relationship between culturally deformed crania and the occurrences of Wormian bones, a scoring system was used which included a detailed assessment of variation known for each trait with other morphological attributes. With this scoring system, it was possible to evaluate eight Wormian bones belonging to the various cranial areas and their hypostatic significance. For example, cranium number T3H1 represented the greatest score (20), where the most evidence of artificial modification is associated with the highest frequencies of Wormian bones which are present in all the sutural segments.

Analyzing Ali Kosh Lady Cranium Modifications

Modification on crania can be easily identified by visual inspections. It is also possible to assess the morphological changes simply by craniometrical methods. As mentioned before, the Ali Kosh lady's cranium was completely disarticulated at the time of its excavation as a result of post-burial processes. By assuming that the cranium had not been affected by cultural deformation, it is necessary to reconstruct essential craniometric indices proposed by Bass (1987) and White (1991) on both the deformed and un-deformed samples so that the comparison can be made. The technique we used here is widely applied in anthropological archaeology and related disciplines to make comparisons on the different physical traits of human groups.

Practically, in order to investigate the possible deformation rage of Ali Kosh Lady's cranium, we compared its measurements against a contemporary undeformed cranium of the same gender, age, and geography, which is now housed at the University of Tehran's Department of Anatomy. Table 1 details the common measurements found for both crania.

This comparison shows interesting results. No meaningful differences can be seen (except

	Bizygomatic breadth	Maximum cranial breadth	Maximum Cranial height	Orbital height	Orbital breadth	Nasal Aperture height	Nasal Aperture breadth	Upper Facial height	Maximum cranial length	Total Facial height
Ali Kosh Cranium	9.23	12.03	110	2.5	2.9	4.8	1.2	6.5	25.48	10.8
Contemporary Cranium	10	12.6	11.1	3.1	3.5	4.8	1.2	5.9	24.42	10

Table 1: *Cranial metrics found for both crania (Ali Kosh Lady and the contemporary cranium).*

a for a few millimeters) between the two cranial measurements, especially for those variables such as maximum cranial length, cranial height, and cranial breadth, whereas it is assumed that greater variations would have been displayed if the cranium had been subjected to modifications.

Furthermore, most artificial modifications lead cranium to form in an annual or ovoid shape, and if Ali Kosh lady's cranium had been artificially modified, we would expect to observe its maximum height to be different from that of a contemporary one. On the other hand, if it had been deformed by compressing a flat board on its occipital and frontal parts, it should display a shape such as the vertico-frontal-occipital or parallelo-frontal-occipital one which we discussed before (fig. 1). In both cases, one of the frontal or occipital bones should be developed obliquely. There is no doubt that if the anterior and posterior parts of a cranium were affected by compressing of any kind, it should be appearing as a flattening form front to back, with compensatory expansion of the parietal region. This kind of modification would lead the cranium to be wide and short in form.

Most importantly, none of the morphological changes affecting deliberately modified skulls that we detailed above (see also Imbeloni 1938, Lambert 1979, Meiklejohn et al. 1992, Özbek 2001 and Ricci et al. 2008) are presented by Ali Kosh's cranium.

If the Ali Kosh lady's cranium shows traces of what Hole has termed *'extreme cranial deformation'* (Hole 1977: 344-345), we should expect to see at least one or some morphological changes which are generally represented by the modified crania. For example, a simple inspection of Ali Kosh lady's cranium indicates that there is no occipital grooving reflective of a depression or concavity caused by diagonal bandaging, and also that any other kinds of grooving discussed (Meiklejohn et al. 1992: 89) are equally completely absent.

We have discussed earlier in this paper the influence of artificial deformation on the expansion of Wormian bones. To assess the presence of Wormian bones, we used X-Ray radiographic photos taken from almost all intact sutural areas of the cranium. The result is consistent with the statement that no visible Wormian bones of any kinds were displayed by this cranium.

Finally, for comparison purposes we have shown our findings virtually with 3ds Max software by manipulating data indices suggested by White (White 1991: 292-293). As the model shows (fig. 3), it seems unlikely that the cranium of Ali Kosh lady was deliberately modified.

Conclusion

We have reported on a re-examination on a well-known cranium assumed to have been culturally modified. We used several diagnostic criteria by examining the morphological change patterns of deformed crania together with Wormian bone development, allowed that the identification of the Ali Kosh lady's cranium does not reflect a significant magnitude of alteration. This is consistent with the results obtained by the craniometric analysis performed to compare the measurements of this cranium with a similar contemporary individual, suggesting that no considerable differences exist between the two crania. These stand in sharp contrast to the statements of certain scholars who have argued for the physical

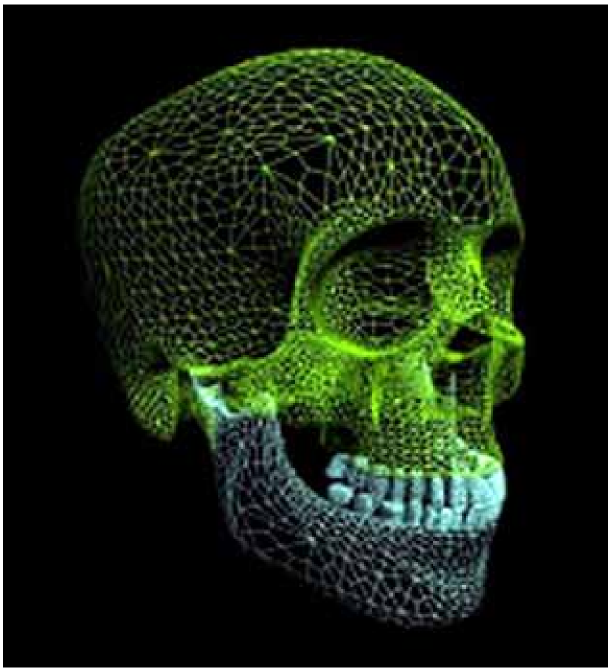

Fig.3: Above: *Lateral view of Ali Kosh Lady's cranium after a primary stabilization.* ***Below:*** *A 3D reconstruction of that cranium.*

deformation of the Ali Kosh lady cranium.

We have argued that the reason for misclassifying the Ali Kosh lady cranium as a deformed type may have been firstly due to its preservation state having prevented any accurate assessment at the time of excavation, and secondly, due to the higher frequencies of deformed crania found over the different phases of the Ali Kosh site excavation (and contemporaneously from the various Near Eastern prehistoric sites), which might as a result, have led Frank Hole to the same claim.

The reader should consider that given the information gleaned from a single cranium analysis, once cannot conclude that head-shaping has never been used as a cultural custom in prehistoric Iran. To the contrary there is in fact, a significant amount of evidence demonstrating that this custom has been practiced not only in Iran, but also in neighboring regions at differing times (e.g. Meiklejohn et al. 1992, Deams and Croucher 2007).

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