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ARTICLE

Cranial deformation and torticollis of an early feudal burial from Byurakn, Armenia

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ABSTRACT The deformities described in this study involved both the skull contour and the cranial base. The custom of deliberate ring deformation of a head was known in the Early Feudal population of the Armenia. The individual had a rhomboid cranial shape. The deformity appeared on the calvarium and cranial base in an early period of life. The calvarial and endocranial base morphology is similar to deformational plagiocephaly (*i.e.*, nonsynostotic plagiocephaly) of patients with associated torticollis. This is the first documented case of torticollis in Armenia.
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The Armenian Highland (also known as the Armenian Plateau, Armenian Upland, or simply as Armenia) is the central and highest of three land-locked plateaus that together form the northern sector of the Middle East (Hewsen 1997). In early history the Armenian highlands were a crossroads linking the worlds of East and West. Those who dominated the Armenian Plateau were in a position to control these lucrative trade routes, to use the fertile valleys that stretch chiefly on the east-west axis, and to dominate the lowlands to the south. Accordingly, Armenia has been an area of frequent military conflicts and its history determined by external forces (Khudaverdyan 2010).

In the transition period from Old Age to Middle Age the feudal (avatatirakan) relations began to develop in Armenia during the reign of Arsacid Dynasty (Arshakuni Dynasty). The rural communities were the major producing households, which were the main taxpayers. But the expansion of nobility's farms at the expense of rural communities greatly increased, leading to division of the national landowning into private estates, *i.e.* into feudal households.

Though the royal power and the main taxpayer to royal treasury, *i.e.* the rural community, which was based on the national landowning system were both preserved in Armenia, the establishment of feudal relationships developed in normal way. In Armenia Feudalism derived from the nakharar system that had patriarchal roots and was a part of the royal power. Armenian statehood was preserved through the Middle Ages by the efforts of nakharar system. In the Middle Ages the Armenian statehood was spread in the Eastern part of Armenia headed by Vachagan the Pious (Barepasht), then in confederation of Armenian kingdoms headed by Bagratid dynasty (Bagratuni dynasty), during the reign of Zakaryan dynasty, princedoms of Sassoun, Artsakh and Syunik, and in the form of Armenian kingdom in Cilicia.

The Armenian society was composed of higher class, *i.e.* the Free (azatner) and lower class, *i.e.* the non-free (anazatner). The Free class was composed of nobility, *i.e.* nakharars owning provinces and also the clergy. The secular representatives of the Free served in cavalry. Over the time an aristocratic class was formed from Arsacid dynasty (Arshakuni dynasty), called the ostaniks. The non-free class was composed of citizens, *i. e.* relatively privileged merchants and craftsmen, the peasants, and also the urban and rural plebeians (ramikner), who could serve only in infantry.

The custom of deliberate ring deformation of a head was known in the ancient population (1st century BC - 3rd century AD) of Armenia (Beniamin,Vardbakh, Shirakavan and Karmrakar) (Khudaverdyan 2011a, 2011b). Many people from Ancient Age deformed the skulls in various ways including daily hand compression or cradleboarding. Deformation of the head in the living is a very old, if not the most ancient, cultural practice leading to changes in one's natural morphology (Senyurek and Tunakan 1951; Ferembach 1970; Özbek 1974; Meiklejohn et al. 1992). According to some authors (Lorentz 2010), a similar tradition existed on all continents. Textiles, leather or cotton straps, and pads were used to flatten heads in different shapes, or give them a tower-like appearance. The deforming apparatus was generally used on newborns a few days after birth (Dembo and Imbelloni 1938; Munizaga 1987) and sometimes it was used until the third year of life (Aufderheide and Rodriguez-Martin 1998). At many people Caucasus, Near, Middle East etc., the newborn child stacked in a cradle where it held about one year, and the first half a year - is constant. The baby tight swaddle to a cradle so there was a deformation of bones of a skull.

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A male skull showing traces of artificial deformation dating back to the 4th millennium BC, and recovered in Dagestan (Ginchi), has been analyzed by Gadzhiev (1975). On the other hand, Batieva (2008), Firshtein (1974) have found evidence of artificial deformation of skulls during the Bronze Age in the area of Lower Don. Shevchenko (1986) has discovered the presence of skull deformation on the burial sites of the Catacomb culture, in what is today Ukraine (c. 2800 – 2200 BC). This author also argues that the practice of skull deformation was brought to the area of the Catacomb culture from the Near East. Other examples of provoked cranial deformation, dated at the 1st century BC – 3rd centuries AD, come from Georgia (Samtavro) and Azerbaijan (Mingechayr) (see Khudaverdyan 1997, 2011a). The skeletal material suggests, however, that the practice of cranial deformation have a longer tradition in the Caucasus, and its origin may be again traced back to the Middle East. Interesting data about this cultural practice in groups from Eurasia is available in anthropological literature (Mednikova 2006). Detailed descriptions and classifications of intentional or unintentional deformed skulls are abundant in the literature (Dembo and Imbelloni 1938; Soto-Heim 2004; Lorentz 2010).

The cranium may be deformed not only due to intentional manipulation, but also due to congenital condition or as a result of postmortem factors in the burial (e.g., pressure) (Ortner 2003). Plagiocephaly is a general term for abnormal asymmetrical cranium shape with unilateral flattening of the anterior or posterior part of the skull. Pathogenically, plagiocephaly can be classified as synostotic (organic) or deformational (positional, functional, postural, nonsynostotic) (Wood and Shell 2005). Synostotic plagiocephaly is caused by premature unilateral fusion of the coronal suture (frontal or anterior synostotic plagiocephaly), lambdoid suture (occipital or posterior synostotic plagiocephaly, true occipital plagiocephaly) or lateral skull sutures (Aufderheide and Rodriguéz-Martín 1998; Wood and Shell 2005; Khudaverdyan 2010). In the literature, the term "hemicranial plagiocephaly" is sometimes used for deformities associated with multiple unilateral sutural fusions (Aufderheide and Rodriguéz-Martín 1998). Deformational occipital (posterior) plagiocephaly is caused by intrauterine and/or postnatal external forces on the one side parietooccipital region of the developing skull (Morrison and Chariker 2006). Occipital synostotic plagiocephaly is characterized by the asymmetrical "trapezoid" skull shape (in vertex view), ipsilateral flattening of the forehead and bulging of the mastoid process (it is pathognomotic for unilambdoid synostose), compensatory contralateral bossing of the forehead and occiput: "pointed" occiput, asymmetry of the ears (ipsilateral ear is situated posterior); facial asymmetry is not mostly severe (Huang et al. 1996; Menard and David 1998; Wood and Shell 2005; Khudaverdyan 2011c). Occipital positional plagiocephaly is associated with asymmetrical "parallelogram" skull shape, unilateral parieto-occipital flattening, ipsilateral frontal bossing, contralateral frontal flattening and occipital bossing, asymmetry of external nose (nasal root is in a midline position but nasal bones and piriform aperture are deviated on the contralateral side), asymmetry of the orbits (contralateral orbit is situated low then ipsilateral orbit), asymmetry of the ear position (ipsilateral ear is situated anterior and superior) (Kelly et al. 1999; Wood and Shell 2005; Martinez-Large et al. 2006). Positional plagiocephaly can be classified as mild (without facial asymmetry) or severe (with facial asymmetry) (Collett et al. 2005).

Torticollis, a twisting of the neck to one side, is one of the most common congenital and acquired anomalies. Asymmetry or plagiocephaly may occur in the presence of prolonged uncorrected head tilt. The term 'torticollis' means twisted neck and is derived from the Latin words 'tortus' and 'collum' (Kahn et al. 1991). One of the earliest written references to this deformity appeared in Plutarch's classic description of Alexander the Great (Plutarch 1958). Various pathologic entities of the head and neck exist that may mimic a positional tilt. Neurological torticollis may result from posterior fossa or cervical spine tumors, syringomyelia or Arnold–Chiari malformations. Klippel–Feil syndrome and rotatory cervical instability constitute the majority of the osseous cases. The remaining categories of nonmuscular torticollis include ocular deficiency, hearing deficit, and Grisel's and Sandifer's syndromes (Ballock and Song 1996; Williams et al. 1996; Berlin 2000; Loder 2001). Congenital muscular torticollis is caused by idiopathic fibrosis of the sternocleidomastoid muscle that restricts movement and pulls the head toward the involved side. The etiology of congenital muscular torticollis is still a topic of debate. Multiple theories exist, including intrauterine crowding or vascular phenomenon, fibrosis from peripartum bleeds, a compartment syndrome, and a primary myopathy of the sternocleidomastoid muscle (Davids et al. 1993; Tang et al. 1998). In other cases, there is only an imbalance in the function of the cervical muscles (Golden et al. 1999). Associated with the asymmetry in posture and movements, there are often primary or secondary abnormalities of the skull and the muscles in the cervical region. In about 8% of cases, torticollis is combined with dysplasia of the hip (Tien et al. 2001). Also found a strong association between asymmetric class III malocclusion, torticollis, and cranial base asymmetry (Yuan et al. 2012). The incidence ranges from 0.3% to 1.9%17,23 with a male preponderance of 3:2, possibly caused by the presence of a larger head circumference in boys at birth (Cheng and Au 1994; Cheng et al. 1999). The characteristic appearance associated with torticollis includes recessed eyebrow and zygoma, deviation of the chin point and nasal tip, inferior orbital dystopia on the affected side, commissural canting toward the affected side, inferiorly and posteriorly positioned ipsilateral ear, and distorted craniofacial skeletal structures (Keller et al. 1986; Ferguson 1993a, 1993b; Hollier et al. 2000).

The aim of this study is the comprehensive evaluation and

Figure 1. Burial Byurakn (photo H. Khachatryan).

quantitative measurement of the craniofacial deformity from a burial in Byurakn.

Material and Methods

The present paper discusses cranial deformation and torticollis uncovered at Byurakn site on the Shirak plateau (Armenia) by the archaeological team directed by Hamazasp Khachatryan and Larisa Eganyan. The site includes a settlement area as well as a large cemetery referred to as Byurakn. It has been excavated 2008. Based on specific components of the pottery assemblage at Byurakn, it is estimated that the site was occupied during the Early phase of the Feudal period (c. 4-5 AD).

Location of a burial within the cemetery, orientation of the body, and funerary offerings might be affected by the social status of the deceased. Spatial relationships among interments were evaluated according to the grid location of each burial, as well as their apparent contiguity. As shown in Figure 1, burial 1 is associated with burial 3, burial 2 - single. I do not exclude that a man (with cranial deformation and torticollis) from Byurakn had a high social status.

Age-at-death and sex were assessed through the use of multiple indicators. Morphological features of the pelvis and cranium were used for the determination of sex (Phenice 1969; Buikstra and Ubelaker 1994). A combination of pubic symphysis (Gilbert and McKern 1973; Katz and Suchey 1986; Meindl et al. 1985), auricular surface changes (Lovejoy et al. 1985), degree of epiphyseal union (Buikstra and Ubelaker 1994), and cranial suture closure (Meindl et al. 1985) were used for adult age estimation. The purpose of this study is to describe and illustrate artificial modification of skulls in Armenia and also the connection between congenital malformation of the cervico–cranium, and a constellation of craniofacial features.

Results and Discussion

A human skeleton recovered from an archaeological context is an invaluable source of information about the past. While still an integral component of a living person, bone tissue responds to a wide range of external influences, recording many of the events of life. Changes in bones and teeth can be provoked by a variety of experiences, including accidents, display and identity- related practices, acts of cruelty or mercy, certain kinds of occupational- related physical activity - or the lack thereof - as well as by childbirth, aging, the effects of climatic shifts, pathogen invasion, and/or the specifics of food composition, caloric intake, and cooking techniques, among other things. Inevitably modified by the individual's behavior during life, a human skeleton recovered from an archaeological context is, in a manner of speaking, an artifact.

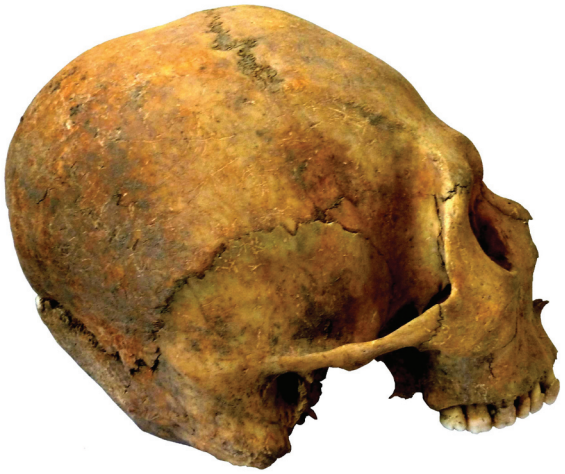

Figure 2. Human cranium from Byurakn (burial 1) showing signs of cranial deformation, likely of the annular type. Notice the post-bregmatic, saddle-like concavity and flattening of the occipital bone.

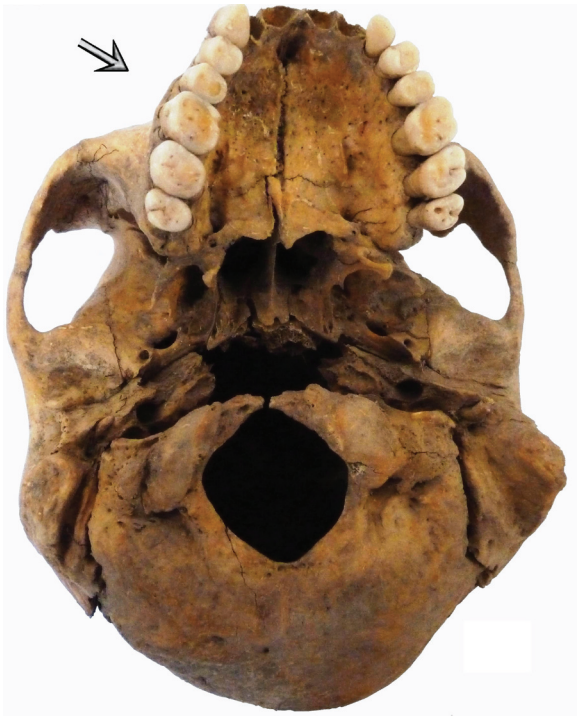

Figure 3. Skull asymmetry (deformational plagiocephaly) without synostosis (Byurakn, burial 1).

A case of artificial cranial modification

Skull and cranial base deformities were apparent on the remains of a male individual from burial no. 1 in Byurakn. Age at death was 20 to 25 years. In skull the most striking morphological alterations are seen in the flattening of the frontal and occipital bones. In the middle of the frontal bone, a flat but distinct circumferential depression with a width of approximately 4 cm is visible. Notice the post-bregmatic, saddle-like concavity (Fig. 2). The cranium exhibits the unambiguous markings of intentional deformation, particularly with respect to a post-bregmatic saddle- shaped depression, demarcated by a low bulge of the frontal bone. A wide ligature was probably passed behind the bregma to affix the device to the occiput. The flattening crosses the frontal tubera and passes beneath the parietal tubera. Above this depression, a bulging of the cranial bone has developed. A second, narrower depression is observable behind the bregma region. This groove is almost perpendicular to the other depression along the temporal bone down. The flattening of the occipital bone is very well visible in comparison to normally developed skulls. Due to the flattening, the skull is longer and higher. Coupled with a pronounced flattening and slant of the occipital bone, this peculiarity suggests use of a head- shaping device attached with ligatures to the cranium during childhood. Relatively low frequencies of evidence for intentional cranial modification at Shirak plateau (Armenia), along with inconsistency in the means of carrying them out, might suggest imitation of foreign practices, rather than well established traditions (Khudaverdyan 2011b).

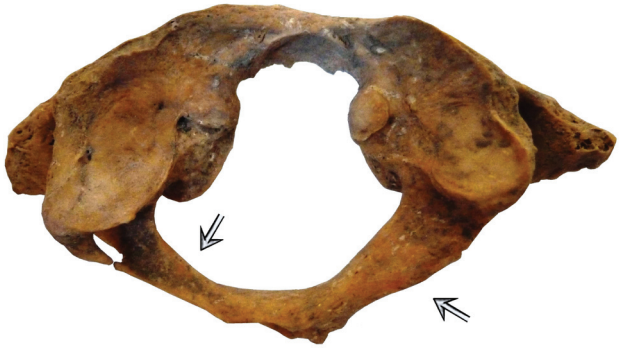

Figure 4. Asymmetrical atlas (C1) (Byurakn, burial 1). The nose was deviated to the left with a prominent nasal bridge and flat nasal tip (Fig. 5).

Torticollis: differential diagnosis

The shape of the craniums from Byurakn trapezoid. The calvarial and endocranial base morphology is similar to deformational plagiocephaly (*i.e.*, nonsynostotic plagiocephaly) of patients with or without associated torticollis (Khudaverdyan 2010, 2011c). Figure 3 showed skull asymmetry in a male (deformational plagiocephaly) without synostosis. The asymmetry is more marked in the right part of the cranial. The cranial sutures were normal in appearance and timing of closure. The deformity is characterised by lateral tilt of the head with rotation of the face. The nose was deviated to

the left with a prominent nasal bridge and flat nasal tip (Fig. 4). Skull and facial asymmetry or plagiocephaly may occur in the presence of prolonged uncorrected head tilt (Chung-Chih et al. 2004). The facial asymmetry in torticollis has been reported to include deviation and flattening of the face on the affected side with recessed eyebrow and zygoma, inferior displacement of the orbit and ear on the affected side, and deviation of the chin point and nasal tip (Keller et al. 1986; Ferguson 1993a, 1993b; Hollier et al. 2000).

The anatomical changes along the entire spine (skull base, craniocervical, thoracic and lumbar) were analyzed of the man from Byurakn. Asymmetry of the skull base could be also observed in man. Occipital condyles also are asymmetric. Differences between left and right side measurements of the arcus posterior of the man ranged from 4 mm (left) and 9 mm (right) (Fig. 5). These differences were related to torticollis.

Torticollis could result in deformities of the developing skull base, cranium, or face. When plagiocephaly and torticollis coexist in a neonate, they could both be the result of a limitation of the intrauterine space that caused persistent asymmetric compression of the cranium and unilateral shortening of the sternocleidomastoid muscle in the final weeks of gestation (Gruss et al. 2002). In cultures where young infants sleep in the supine position, unilateral compression of the skull base will occur in the child with torticollis if there is rotation of the chin away from the shortened muscle (Gruss et al. 2002). Unilateral shortening of the sternocleidomastoid muscle causes the young infant to consistently position the head on the occiput contralateral to the tight sternocleidomastoid muscle while unloading the occiput on the ipsilateral side. With continued unilateral weight bearing, the skull base and cranium will deform so that the vertex view reveals a parallelogram-shaped head (Yu et al. 2004). The study showed that the deformity appeared on the cranium and cranial base at an early period of life, and the facial deformity occurred at a later stage (Chung-Chih et al. 2004). It also was found that the severity of cranial and facial deformity was correlated with age.

Torticollis is often a clinical manifestation of a congenital osseous cervical spine anomaly. The atlas serves as a washer between the occipital condyles and the axis vertebra. The atlantooccipital articulations allows for some flexion/extension, minimal lateral bending, and little axial rotation. In the presence of a congenital vertebral anomaly, there is an asymmetric deficiency in either the number of growth plates or their rate of growth on one side of the spine. In regard to the atlas (C1) vertebra, the asymmetry reported in earlier chiropractic literature pertains to differences of lateral mass height (Remier 1952). More recent literature also indicates that the atlas is asymmetrical (Gottlieb 1994; Huggare and Houghton 1995; Ross et al. 1999; Briggs et al. 2008).

Although asymmetrical skull deformities are quite common today, not many cases have been described in the paleo-

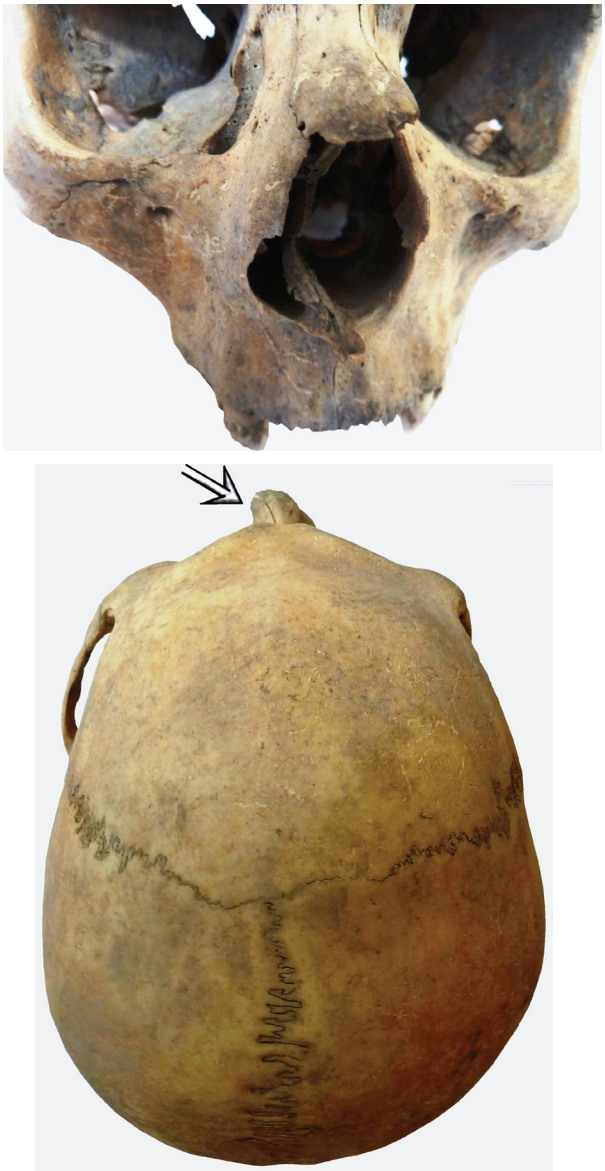

Figure 5. Remarkable deviation of the nasal tip (Byurakn, burial 1). Differences between left and right side measurements of the arcus posterior of the man ranged from 4 mm (left) and 9 mm (right) (Fig. 4).

pathological literature (Aufderheide and Rodriguéz-Martín 1998). Positional plagiocephaly is the most common cause of plagiocephaly (Petsch et al. 2002). It results from asymmetrical cranial growth without craniosynostosis. The practice of artificial skull deformation dates back to 9th millennium BC when several ancient civilizations have used head-molding to produce desired skull shape. Positional occipital plagiocephaly is caused by constant external pressure on the one side parieto-occipital region of the developing skull (Collett et al. 2005). Risk factors associated with the positional head deformity are prolonged exposure to traditional "back" sleep-

ing position, premature birth, congenital muscular torticollis, and intrauterine constraint (e. g. in multiple gestation or oligohydramnion) (Morrison and Chariker 2006). High positional plagiocephaly occurrence in this skull from the historical populations of Byurakn was probably predominately caused by congenital muscular torticollis.

The findings showed that the torticollis and cranial deformation took place in childhood. Despite all these deformities, this individual survived, suggesting that his pathological condition was not an impediment during his life. The individual was engaged in considerable physical activities. The postcranial section of the skeleton can be characterized as moderately massive. The arthritic changes and bone "overgrowth" changes at tendon and ligament attachment sites (especially at the elbow, hip and tibia) appear to be owing to muscle overuse. He also tends to use muscles primarily in humerus (M. pertoralis major, M. deltoideus), radius (M. biseps brachii) and femur (M. gluteus maximus). The male not revealed cribra orbitalia and porotic hyperostosis, hypoplasia of dental enamel, periosteal reaction, osteomyelitis and dental pathology.

Conclusions

The custom of deliberate ring deformation of a head was known in the Early Feudal population of the Armenia. This study deals with a case of craniofacial deformity with congenital muscular torticollis. The deformity appeared on the calvarium and cranial base in an early period of life. The individual had rhomboid cranial shape. The calvarial and endocranial base morphology is similar to deformational plagiocephaly (*i.e.*, nonsynostotic plagiocephaly) of patients with associated torticollis. This is the first documented case of torticollis in Armenia.

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