Interpersonal violence among the Chalcolithic and Bronze Ages inhabitants living on the Central Plateau of Iran: A voice from *Tepe Hissar*

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With 12 figures and 6 tables

Summary: The site of Tepe Hissar (Iran) experienced widespread cultural and economic changes during the Chalcolithic and Bronze Ages (5th to the 2nd millennium B.C.). The discovery of evidence of burning, including charred human remains, the destruction of buildings (Periods II and III), and the presence of several mass-burials with comingling of human skeletal remains consisting of ten or more individuals (Period III), suggests interpersonal violence during these periods. The original excavator of Tepe Hissar, Erich Schmidt, suggested that phenomena such as war, massacres, epidemics, or similar catastrophes, may have been responsible for the excavated archaeological evidence. This study tests the hypothesis that interpersonal violence was responsible for this evidence. Patterns of violence related head injury are explored among 129 adult men and women from the Chalcolithic and Bronze Ages. Sixty of the 129 (46.5%) crania examined presented with cranial trauma, with 25 (19.3%) having evidence of perimortem injury, and four (3.1%) and 31 (24%) individuals with signs of healing and healed head/facial trauma, respectively. Most of the injuries were located on the frontal or parietal bones of the cranium. Such findings may be interpreted as a result of the population experiencing a rise in social complexity and population increase that accompanied violence related to intra- or inter-group competition, often leading to lethal outcomes. These data support the hypothesis that the cultural and economic transitions and population changes that occurred at Tepe Hissar, and particularly in the Hissar II and III periods, were accompanied by tension and interpersonal violence.

Key Words: skull trauma, cultural changes, violence, prehistoric period, Iran

Introduction

Skeletal trauma identified in archaeological populations is the most direct evidence for testing hypotheses about interpersonal violence and aggressive behavior in the past (Walker, 2001; Novak, 2007). Analysis of weapon related trauma, for example wounds caused by sharp implements such as weapons and projectiles, along with scalping, can be a direct source of evidence for conflict and interpersonal aggression in past societies (Boylston, 2000:357; Walker, 2001; Murphy, 2003:69; Novak, 2007). Applying methods developed in clinical and forensic medicine, many bioarchaeologists have explored the pattern and causes of violence related injuries in archaeological populations from around the world. These have included, for example, interpersonal/group conflict with evidence of lethal trauma, unhealed injuries and mutilation (Milner et al., 1991; Wilkinson, 1997), interpersonal violence as a sociocultural problem, as seen in cranial trauma and cut marks (Walker, 1997; Frayer, 1997; Fibiger et al., 2013), and warfare/intergroup violence/massacre, as seen in cut marks and fractures (Walker, 1989; Jurmain, 1991; Teschler-Nicola et al., 1999; Wild et al., 2004; Novak, 2007; Arkush and Tung, 2013; Meyer et al., 2015).

However, published data on trauma from archaeological populations from Iran are scarce (Monge and McCarthy, 2011- Iron Age, Hasanlu- Northwestern Iran; Afshar, 2015- Chalcolithic and Bronze Ages, Tepe Hissar- Northeastern Central Iranian Plateau). The current study investigates craniofacial trauma in adult human remains from Tepe Hissar, Iran dated from the 5th to the 2nd millennium B.C. Human remains from this site provide a unique opportunity to assess violence and intra/inter personal conflict among one of the oldest skeletal populations in Iran. This research is the first of its kind in studies of the "archaeology of Central Iranian Plateau", and has opened a new window on evidence that is central to gaining an understanding of the lives and social environments of the Chalcolithic and Bronze Ages population buried at Tepe Hissar.

Tepe Hissar represents one of the largest known urban settlements in the Central Iranian Plateau (Fig. 1, Table. 1) and was inhabited during the late 5th to the early 1st millennium B.C. through the historic phases (300- 600 AD) to the Islamic period (middle Islamic period , ~1400 AD- Schmidt, 1933, 1937; Dyson and Howard, 1989; Roustaei, 2006, 2010). Archaeological evidence shows that, during the Chalcolithic and Bronze Ages (late 5th to the 2nd millennium B.C.), the site experienced widespread cultural and economic changes. Site abandonment and reoccupation occurred periodically at the site, and has traditionally been explained by the "arrival" of new populations in this locality (Schmidt, 1933, 1937). Tepe Hissar is located on the southern slopes of the Alburz Mountains on the Damghan Plain- on the major trade routes along the "Silk Road" which connect Central Asia in the East to Mesopotamia and the Persian Gulf in the West (Pigott et al., 1982). It is a complex of disconnected irregular mounds and flat areas (Fig. 2), comprising a total area of about 12 hectares (Dyson and Tosi, 1989). Tepe Hissar was first excavated in the 1930s by Erich Schmidt (Schmidt, 1933, 1937), and in 1979 a re-investigation project was undertaken by the University of Pennsylvania Museum, Turin University, and the Iran Centre for Archaeological Research (Dyson and Howard, 1989). In more recent times in 1995, 2006 and 2010, research was carried out solely by the Iranian team, directed by Yaghmaei and Roustaei (Roustaei, 2006, 2010).

(Table 1 here)
[Figure 1 here]

Archaeological evidence for the three Tepe Hissar periods

The archaeological sequence at Tepe Hissar (Table. 1) indicates a sudden appearance and development of the settlement (Hissar I period- 4300-3700 B.C.) in the late 5th millennium B.C. (Schmidt, 1937; Majidzadeh, 1981, 2008:69). During the mid-early 4th millennium B.C., the site underwent an extreme cultural shift and entered a new era (Hissar II period- 3700-2900 B.C.). The appearance of "grey pottery", followed by the disappearance of the Hissar I "painted pottery", coupled with new mortuary practices, a new architectural style for buildings, a remarkable increase in industrial activity and long distance trade, suggests the arrival of new "Hissar II people" at the site (Schmidt, 1937; McCown, 1942:11). Nevertheless, archaeological evidence of "burning", including burnt human remains, and "destruction" of buildings (Schmidt, 1933, 1937) dated to Hissar II, suggests that these cultural changes may have been accompanied by "traumatic" events (intentional), particularly at the end of Hissar II.

[Figure 2 here]

Again, in the very early 3rd millennium B.C., this site underwent a second cultural transition, suggesting that a "dynamic force" or "foreign influence" changed the life of the

population during the Hissar II period with another new era entered (Hissar III period – 2900-1700 B.C.- Schmidt, 1937). The site was abandoned and used as a burial ground for a short period, but was reoccupied again with new people (Hissar III - Tosi and Bulgarelli, 1989:44). Nevertheless, evidence of "burning and destruction" in buildings from the beginning of the Hissar III period, "charred" human skeletal remains, as well as several "mass burials" (Schmidt, 1933, 1937- Fig. 12), suggests that during this time the site may have experienced intra- or inter-group conflict/violence. In the first half of the 2nd millennium B.C., the Bronze Age settlement of Tepe Hissar was abandoned (Schmidt, 1937:308).

Studies of cranial and dental metrical and non-metrical data from Tepe Hissar (Chalcolithic and Bronze Ages) suggest that the site was occupied by different groups of people during each period, possibly with a different genetic makeup. This indicates that cultural, social, and economic changes may have been accompanied by biological changes and perhaps "exchanges" with migrants (Afshar, 2015; Afshar et al., in review).

The hypothesis to be explored in this study relates to whether changes in cultural, economic and social spheres, but particularly in Hissar Periods II and III were accompanied by tension/competition and interpersonal/group violence (cranial injury), alongside archaeological evidence of burning, destruction of buildings, tools of war, and mass burials. There is currently no published information regarding cranial trauma and interpersonal violence from this site or from other Chalcolithic and Bronze Age sites in Iran, and therefore this study stands as a unique and original contribution to understanding the dynamics of these periods, and in particular provides the first evidence of violence related trauma in a Chalcolithic and Bronze Age population from Iran.

Past skeletal studies of Tepe Hissar: the UPM collection

The first study of the Tepe Hissar skeletal remains was done by Wilton Krogman (1940a and b), focusing on "racial" types represented by the recovered crania. He (1940c) also gave a basic report and a brief overview on the skeletal and dental pathologies. Later, Mario Cappieri (1973) used the metrical data to compare variation between South Asian populations. In more recent years, Hemphill has led a number of craniometric studies (Hemphill et al., 1997; Hemphill, 1998, 1999a-b; Hemphill and Mallory, 2004) in their comparative analyses of relative variation among the Oxus Civilization and Bronze Age Iran and the Indus-valley populations. Afshar (2006) compared biological affinity between people from Tepe Hissar (Hissar II and III) and people buried in the Bronze and Iron Age south Caspian Sea region (Shah Tepe, Gohar Tepe, and Dailaman). Recently, the first author in her doctoral research on 'Mobility and economic transition in the 5th to the 2nd millennium BC in the population of the Central Iranian Plateau, Tepe Hissar', conducted a bioarchaeological study of the Tepe Hissar skeletons curated at Penn Museum (see below), including carbon and nitrogen stable isotope analysis. The aim was to advance understanding of population movement and replacement, and the impact of sociocultural and economic changes on mobility, subsistence economy, diet, health and disease, and interpersonal violence during the Chalcolithic and Bronze Ages (Afshar, 2015). This paper thus comprises a small part of this research.

Materials and Methods

Clinical, forensic, as well as bioarchaeological data, have shown that the head and face areas are the most frequently targeted regions of the body in interpersonal violence, when compared to postcranial bone evidence - except parry fractures (Brink et al., 1998; Judd, 2002, 2004; Novak, 2007; Brink, 2009; Glencross and Boz, 2014:103), and therefore are useful for measuring levels of violent conflict in archaeological contexts (Lambert, 1997:82).

For this reason, and because the majority of skeletons from Tepe Hissar were in a poor/partial state of preservation, this study recorded cranial and facial trauma in adult individuals.

There was a total of 1637 human skeletons uncovered during excavations by Schmidt at Tepe Hissar (1933, 1937), and 397 (about 24.2%, adult and non-adult) of the skeletons are curated at the University of Pennsylvania's Penn Museum, in the Department of Archaeology and Anthropology (UPM). Unfortunately, the rest of the skeletons may have been reburied or curated in an unknown place in Iran. However, it is not known whether Schmidt selected them randomly, by sex or age, or based his selection on the presence of disease, the place where he uncovered them, preservation/completeness, or perhaps period or other unknown criteria. The skeletal remains at UPM are dated from the Chalcolithic to the Bronze Age (late 5^{th} -2^{nd} millennium B.C- Hissar I, II and III), from an "unknown" period, and the Islamic period (see above). The focus of this research was the human remains dating from the early Chalcolithic to the Bronze Age (late 5^{th}- 2^{nd} millennium B.C.). While there was a total of 368 adult individuals available for study from these periods, cranial trauma and its patterning was examined in 129 (35.3%) adult crania preserved and available for study from the three periods by the first author (see Table. 2). The rest of the skeletons did not have preserved crania. Unfortunately, all the skeletons from the mass burials and communal burial were not available in the Tepe Hissar collection for a cranial trauma study. Only 12 individuals from Hissar III were from the communal and mass burials (five females and seven males).

Cranial and facial trauma was analysed macroscopically using methods based on Ortner (2003:119-143), Boylston (2000, 2004), and Buikstra and Ubelaker (1994:160), as well as forensic anthropological techniques (Chacón et al., 2008; Kimmerle and Baraybar, 2008). Cranial trauma was recorded based on the type and location of the injury on skull, and whether it was healed or not.

Determination of sex and age

Multiple ageing and sexing methods were utilized. Estimation of sex was based on sexually dimorphic traits of the cranium and mandible (Acsádi and Nemeskéri, 1970:87-90; Buikstra and Ubelaker, 1994:19-20; Loth and Henneberg, 1996) and pelvis (Phenice, 1969; Acsádi and Nemeskéri, 1970:75-79; Buikstra and Ubelaker, 1994:16-19; Bass, 1995:202). Measurements of long bones such as the femoral, humeral and radial-head diameters, the femoral-bicondylar width, clavicle length, and scapula-glenoid width were also recorded to aid sex estimation (Bass, 1995; Afshar, 2015). Age-at-death estimation was based on the final stages of growth including molar eruption (van Beek, 1983; Ubelaker, 2004:64), and fusion of the spheno-occipital synchondrosis, the iliac crest, the ischial tuberosity, the first two segments of the sacrum, and the medial and sternal end of the clavicle (Black and Scheuer, 1996; Scheuer and Black, 2000:4-17). Morphological and degenerative changes also examined included cranial suture closure (Meindl and Lovejoy, 1985), degenerative changes in the auricular surface of the ilium (Lovejoy et al., 1985b), pubic symphysis morphology (Brooks and Suchey, 1990), and dental attrition (Miles, 1962, 1963; Brothwell, 1981:72). Other age related traits that are more likely present in older adults were also considered, including antemortem tooth loss and osteoporosis (Lovejoy et al., 1985a), and joint disease (osteoarthritis: Rogers and Waldron, 1995). The age categories utilized were based on Buikstra and Ubelaker's (1994:36) recommendations, but to obtain more nuanced information, the young adult class was divided into two: young adult 1 (YA1, 18-25 years), young adult 2 (YA2, 26-35 years), middle adult (MA, 36-50 years), old adult (OA, 50+), and adult (AA, 18+) (Afshar, 2015).

Identifying cranial trauma

Cranial and facial injuries were identified as either antemortem (well healed or healing wounds) or perimortem (Merbs, 1989; Sauer, 1998:322-324; Novak, 2007). Antemortem trauma is characterised by trauma occurring earlier in the individual's life, i.e. the trauma did not kill the person. This type of trauma can be recognized by the presence of new bone formation, reflecting healing and remodelling of the lesion (Sauer, 1998). Evidence of antemortem trauma was recorded because it may indicate previous interpersonal conflict that the person survived. Perimortem trauma refers to injury occurring at or around the time of death and was probably associated with the cause and manner of death, as indicated by a lack of healing (Sauer, 1998; Kranioti, 2015). However, cause of death may be specifically related to soft tissue injury, which is generally not seen in skeletal remains unless the soft tissue ossifies. Perimortem fractures were distinguished as blunt, sharp, or projectile force, depending on their morphology and the size of the wound (Berryman and Symes, 1998; Kimmerle and Baraybar, 2008).

"Blunt" force injuries are produced by blunt instruments, blast injuries, or during falls, and blunt force trauma located in the cranium is often associated with the cause of death (Kranioti, 2015). Cranial injuries resulting from this type of trauma primarily consist of comminuted, depressed, and radiating fractures (Raul et al., 2008; Finegan, 2008). If the force is great it may produce a detailed delineation of the weapon margin. The area around the impact bends outwards and the centre is depressed inwards (Boylston, 2000:363; Novak, 2007:91; Finegan, 2008). "Sharp" force injuries are usually produced by bladed objects such as swords and daggers and can generally be easily recognized on the bones of a skeleton. Blade injuries tend to be linear, with a well-defined clean edge, and have a flat, smooth, polished cut surface, often with parallel scratch marks on the bone surface (Lew and Matshes, 2005; Novak, 2007:91; Chacón et al., 2008). Sharp edged weapons can also produce stab wounds, which are deeper and have a polished margin, but the cut marks tend to be superficial and wider rather than deep, with burnished and parallel edges (Chacón et al., 2008). "Projectile" trauma is usually characterized by the velocity at which the weapon contacts the body. These injuries are produced by sharp edged weapons such as those made of stone, bone, metal, and wood, and by bullets, arrows, or spears which penetrate bone (Lambert, 1997:90; Boylston, 2000:363; Raul et al., 2008). The wound produced is small and circular, and has distinct entrance and exit holes, indicated by bone flaking around the margin of the bone affected (Novak, 2007:91; Raul et al., 2008). Weapons with a high velocity can also produce extensive fractures. The nature of this type of injury implies lethal intent (Lambert, 1997:90; Rickman and Smith, 2014).

Since both postmortem breaks and perimortem fractures will have no evidence of bone formation (healing) on and around the injuries, special attention was paid to accurately identify perimortem injury, based on the morphology and colour of the fracture margin (Boylston, 2000, 2004; Roberts and Manchester, 2005:89; Dirkmaat et al., 2008). Postmortem trauma is clearly distinguishable as having a lighter fracture margin compared to the bone surface, a rougher texture, and rectangular broken edges to the fracture surfaces (Lambert, 1997:84; Novak, 2007:91; Dirkmaat et al., 2008).

Statistical analysis

The chi-square test was employed to explore differences in the prevalence of trauma within and between the Tepe Hissar population groups, by sex and age category. In the case of small sample sizes not meeting the assumptions needed for the chi-square test, Fisher's exact test was used (Fletcher and Lock, 2005). The significance level, p-value was set at 0.05, and therefore only p-values less than (or equal to) 0.05 were considered significant.

Results

Table 3 shows the number of crania examined and the frequency of ante- and perimortem cranial injury among females and males from the three periods.

(Table 3 here)

During the Hissar I period, of two crania examined (a male and a female), that of the female presented evidence of cranial perimortem injury (Fig. 3).

[Figure 3 here]

The frequency of antemortem cranial trauma was higher among women from Hissar II compared to men, but the prevalence of perimortem trauma was higher in males; however, this was insignificant. During the Hissar III period men showed a higher rate of healed cranial injury compared to women, but the rate of lethal head trauma was higher for women for this period. These differences were not statistically significant.

Comparing the total prevalence of cranial trauma in each period (Table. 3), the Hissar II group exhibited a marginally higher prevalence (47%) compared to the Hissar III group (46%), but the difference was insignificant (χ^2=5.983, p=0.742). The percentage of lethal cranial injury was higher for people from Hissar II period (23.5%) compared to Hissar III (17.9% - insignificant χ^2=5.112, p=0.738). The rate was 50% for Hissar I, but the sample size was not adequate to legitimately compare frequency rates. In the Hissar II period the frequency of injuries in people with evidence of healing was also higher (6%) than in Hissar III (2.7%). In contrast, the frequency of healed cranial injuries was higher in Hissar III (25.4%) compared to Hissar II (17.6% - insignificant χ^2=5.587, p=0.445).

Comparison of the frequency of ante- and perimortem cranial injuries among the different adult age categories at Tepe Hissar is shown in Table 4. In both the Hissar II and III periods the evidence of perimortem injury was seen across different age groups, but in Hissar III the MA men (42.1%) and women (40%) had a higher prevalence compared to those in the other age groups (insignificant χ^2=4.647, p=0.365). The YA (11.8%) and YA2 (12.5%) females from Hissar III exhibited a higher frequency of perimortem injuries compared to YA1 and YA2 males (5.5% and 7.4%, respectively - insignificant).

The distribution pattern of antemortem head trauma indicates a higher prevalence in YA2 and MA women from Hissar II than for men in these age groups, and Hissar III males and females showed different frequencies. Antemortem cranial injury was recorded with a higher frequency for YA1 (11.1%) and YA2 (33.3%) males compared to females (5.9%, 18.7%, respectively). In contrast, MA women exhibited the highest frequency of cranial injury (60%) compared to men (42.1%) and the younger adult age groups for both sexes. These differences were insignificant.

(Table 4 here)

Table 5 shows the distribution of ante- and perimortem cranial injuries based on their location. The frequency of frontal bone trauma was higher during the Hissar II period (male 14.3%, female 20%) compared to Hissar III (male 4.5%, female 9.3%). In contrast, during Hissar III parietal bone injuries were more prevalent (male 32.8%, female 27.9%), and one individual had occipital bone trauma (2.3%). There was evidence of trauma on the orbital (3%) and nasal (1.5%) bones in individuals from Hissar III. Some people buried during Hissar II and III exhibited more than one cranial injury (between one and three), with a higher frequency in individuals from Hissar II. The frequency for frontal bone trauma was

greater among women (Hissar II, III) compared to men. However, males had a higher frequency of injury to the parietal bones compared to females.

(Table 5 here)

There were a total of 35 individuals (Hissar II, III) who exhibited antemortem cranial trauma (Fig. 4), and all of them variously displayed round, elliptical, or linear depression (nasal and orbital) fractures, suggesting a pattern of blunt force injury. However, from a total of 25 individuals with evidence of perimortem cranial injury, 15 people exhibited blunt force trauma, three showed sharp force, and seven had puncture wounds (Table. 6, Figs. 5-6). Blunt force trauma was seen more at Tepe Hissar than sharp and puncture force trauma and at a higher rate in individuals from Hissar III (60%) compared to Hissar II (50%). The only female from Hissar I had a perimortem injury related to blunt force trauma. One of the individuals from Hissar II (25%) and two from Hissar III (10%) exhibited sharp force trauma. Evidence of puncture wounds was more frequent during Hissar III with six individuals exhibiting this type of injury (30%). The majority of perimortem cranial injuries affected parietal bones, with a frequency of over 75% (65% on left parietal and 35% on the right parietal), but the frequency for frontal bone injury was less than 25%.

(Table 6 here)
[Figure 4 here]
[Figure 5 here]
[Figure 6 here]

Discussion

It was hypothesised that people buried at Tepe Hissar had experienced cranial injury due to tension and violence, caused by sociocultural and economic changes at the settlement, alongside population influxes during the Chalcolithic and Bronze Age (late 5th to the 2nd millennium B.C.). The cranial trauma data in the people buried during the three periods supports this hypothesis and provides direct evidence for interpersonal aggressive behaviour, and this affected both sexes and different age groups alike. The data from the 129 crania available for study (7.9% of the total population recovered; n=1637) showed a high frequency (46%) of traumatic lesions to the skull in individuals from the three periods; 19.3% had evidence of perimortem head injury and 27.1% had signs of antemortem head trauma. The majority of cranial injuries were located superior to the parietal (the majority on the right side- see above) and frontal bones. Head trauma above this level is most consistent with a violent blow than an accidental cause, such as a fall (Glencross and Boz, 2014:112), and also consistent with face to face or hand to hand combat (Walker, 1997; Erfan et al., 2009). For example, a study of cranial trauma in skeletons from the Bahriyah Oasis, Egypt (332 B.C-395 A.D) showed that the most afflicted cranial bones with evidence of lethal injury were the parietal (65.9%), followed by the frontal bone (27.3%), and then the occipital bone (6.8%), suggesting face to face conflict (Erfan et al., 2009). A study of skeletal remains from the Iron Age sites of Hasanlu and Dinkha Tepe, northwest Iran, also show a high frequency of both frontal and parietal bone wounds among males (57%), suggesting interpersonal violence (Monge and McCarthy, 2011).

Archaeological evidence from late Hissar I shows the presence of “spearheads”, copper “daggers” and “blades” as grave goods in some graves (Fig. 7). These types of artefacts were not present in earlier graves from this period (Schmidt, 1937:82). The results from the study of cranial trauma showed that one of two crania examined from Hissar I had evidence of perimortem injury (Fig. 3), which may have contributed to the cause of death of this

individual, but the small sample size from this period must be considered. Schmidt (Unpublished Archive - Penn Museum) also discovered a communal/mass (?) burial (Plot CG 95- see Fig. 12) containing six skulls. He dated this burial to early Hissar I. None of the skulls from this communal burial were available for the current study, but if this is accepted as a mass burial then perhaps the people buried during the early phase of Hissar I were also faced with interpersonal conflict.

[Figure 7 here]

The archaeological evidence from Hissar II shows "tools of war" (Fig. 8), evidence of frequent burning and subsequent destruction of structures, and charred human remains, particularly from the second-half of this period (3400-2900 B.C.), accompanied by abandonment of the site (Howard, 1989:57; Tosi, 1989). The cranial trauma data from the Hissar II individuals correspond to the archaeological data and provide direct evidence of interpersonal and/or intergroup violence, both lethal and non-lethal, having been prevalent at Tepe Hissar during this period. This supports the hypothesis that cultural changes and population influx in this period were accompanied by aggression.

The data showed that 23.5% (4/17) of Hissar II individuals had perimortem head injuries. Studies of conflict related trauma show that frequencies of perimortem injuries usually exceed 25% in cases of massacres, ritualized violence, or in battlefield cemeteries (Novak, 2007; Murphy et al., 2010), and this may be the case for Hissar II. Men and women were both victims of violent assault, but the presence of females among homicide victims suggests that the conflict may have been on home territory (Giles and Hyndman, 2004; Buvinić et al., 2013:8). People with healed cranial trauma may have survived previous attacks, or perhaps the healed wounds imply the existence of interpersonal or intergroup fighting without an intention to kill one's opponent (Glencross and Boz, 2014:117), or people could have received treatment for their injuries. Nevertheless, the cranial injury data suggest a possible group competition, stress, and physical confrontation during the Hissar II period. Some of this confrontation obviously caused the death of some individuals and may have been one of the reasons for the collapse of Hissar II Period. While this study did not attempt to cross-match the morphological characteristics of the wounds with weapons from the site, since the weapons were not accessible for this study, the type of cranial injuries observed indicates a brutal conflict between individuals buried at this site using very efficient weapons of war. The quadrangular shaped/ projectile wounds on the skulls of people buried during both the Hissar II and III periods (Fig. 5) are similar to injuries on warriors from Pazyryk tumuli in the Mongolian Altai, Central Asia (5th century B.C.- Jordana et al., 2009) and individuals from the medieval battlefield cemetery of Towton, England (1461 AD) (Novak, 2007). In this latter case, it has been suggested that these wounds may have been produced by specific weapons, with an armor-piercing arrowheads or war hammers (Novak, 2007), being among the weapons discovered from both Hissar II and III.

[Figure 8 here]

Archaeological excavations from Hissar III show that new weapons occurred at that time (Fig. 9), and several "mass burials" (Plots DG 00, DG 01, DG 11, CH 75, CH 85, DH 05, DH 06, DG 96- Fig. 10) or "communal burials" (Plot DF 29- from Schmidt's Unpublished Archive), with some containing several adult skulls (between five and 10 - Fig. 10 and 12), and others including a number of disarticulated/"interlocked" adult skeletons (between five and 13). On the other hand, there is wide ranging evidence to suggest that living during the Hissar III may not have been peaceful; evidence includes the appearance of single burials

with “missing skulls”, burials consisting only of a skull, burnt buildings and charred human skeletal remains (Fig. 11- Schmidt, 1937:219; Dyson and Remsen, 1989:97), “warrior” graves, and finally evidence of the collapse of Tepe Hissar in period III. The cranial trauma data from this period support the hypothesis of conflict and violence and also correspond to the archaeological evidence of violence from this period. There is evidence of cranial injury, both lethal and non-lethal, for some individuals from Hissar III. Almost 18.2% (20/110) of people buried during Hissar III experienced intentional assault (Figs. 5-6, Table. 6), with both men and women within different age categories suffering violent attacks alike. This suggests that the conflict may have been on home territory (Giles and Hyndman, 2004; Buvinić et al., 2013:8) as seen in the Hissar II period. Among individuals with perimortem head trauma, four graves only preserved a skull, and none had grave goods. Only two of the seven individuals from the communal and mass burials (Plots DF 29 and DG 00) exhibited perimortem cranial injury, while the rest of the individuals (available for this study) from communal (Plot DF 29) and mass burials (Plots DG 00, DG 01, DH 06- Fig. 12) showed only antemortem/healed cranial trauma. Unfortunately, all the individuals from the mass and communal burials, or burials with “only” a skull to represent them, were not available for this study. In the current study, none of the individuals with perimortem cranial trauma were buried with weapons, and 60% of the individuals with cranial injury did not have any grave goods, compared to the people without injury (53.6 % (59/110)).

The presence of antemortem cranial wounds, suggests these individuals may have survived previous violent or possibly received treatment. Both men and women from different age groups may have experienced some episodes of tension and interpersonal conflict within their community during their lives (from early adulthood through to old age) or may have survived previous attacks. The occurrence of both lethal and non-lethal parietal bone injuries in men and women (32.8% and 27.9%, respectively- Table. 5) followed by frontal bone injuries (4.5% and 9.3%, respectively) suggests face to face assaults (Walker, 1997; Erfan et al., 2009). A small percentage of males from Hissar III showed healed nasal and orbital bone trauma, and this also suggests face to face confrontation.

[Figure 9 here]
[Figure 10 here]
[Figure 11 here]
[Figure 12 here]

Conclusions

Overall, this study reveals a picture of violence incorporating the use of weaponry during the Chalcolithic and Bronze Ages of Tepe Hissar (5th to the 2nd millennium B.C.) in the Central Iranian Plateau. It supports the hypothesis proposed. Violent conflict occurred in all three periods, but the small sample size from Hissar I must be noted. Both sexes and different age groups were victims of violence in both the Hissar II and Hissar III periods, suggesting that attack probably occurred at the site, and this corresponds to evidence of burnt buildings and charred human skeletal remains discovered from both periods. The evidence for antemortem cranial trauma also indicates interpersonal aggression at site. The level of violent head injury at Tepe Hissar suggests that helmets may not have been used during combats.

Nevertheless, it is necessary to note that the actual prevalence of violence at Tepe Hissar is probably underestimated, since the skeletal remains analysed in this study are a small proportion of the overall Tepe Hissar population (129/1637 – 7.9%), and this research only focused on violent cranial trauma; this is because evidence of head injury has proved to be a useful measure of violent conflict in archaeological societies (Lambert, 1997:82). On the other hand, clinical data for trauma shows that many interpersonal violent injuries are soft

tissue injuries and would not leave their imprint on bones (Walker, 2001). In addition, it is normally considered good practice to consider evidence for trauma in the rest of the bones of the skeleton when interpreting interpersonal violence. However, the postcranial preservation and availability for study of this skeletal collection prevented being able to conduct a wider distribution pattern study. Nevertheless, this is the first study of violent trauma/or head injury in an ancient Iranian Plateau population. It provides data that will be of comparative use for future studies in Iran and for the wider world.

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Figure captions

Figure 1. Map of Iran and geographic location of Tepe Hissar (redrawn from Wikimedia, https://en.wikipedia.org/wiki/Iranian_Plateau)

751 **Figure 2.** Aerial view of the site of Tepe Hissar (Mousavi and Sumner, 2012: Pl.19)

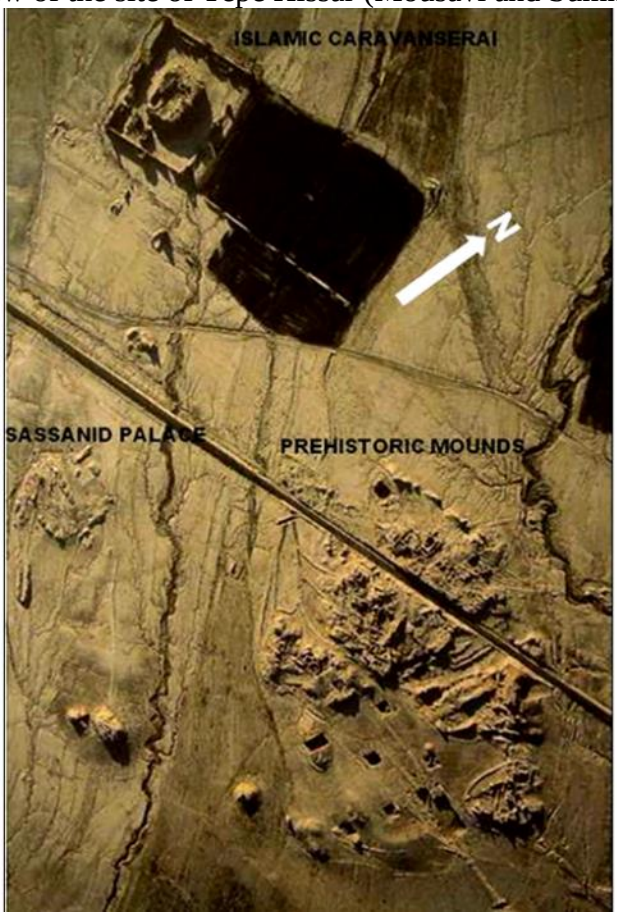

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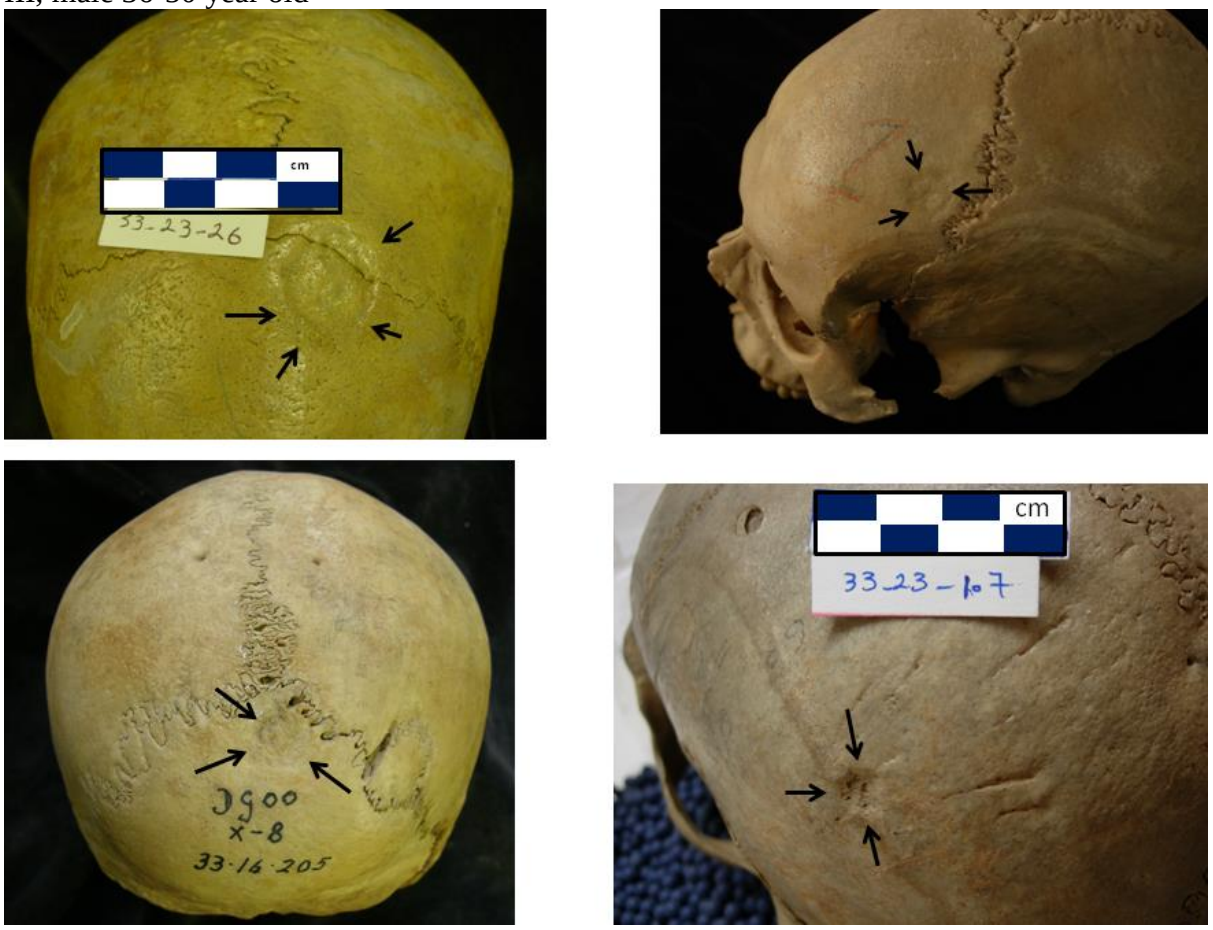
Figure 3. Hissar I: female between 18-25 year old (Sk 33-23-7) - Upper: perimortem blunt force trauma of the skull vault (24 × 12 mm, ectocranial surface of the left parietal); Lower: with some parts of bone from the fracture displaced endocranially

Figure 4. Some examples of antemortem cranial trauma from Hissar II and III- Upper left: Sk 33-23-26, Hissar II, female 26-35 year old; Lower left: Sk 33-16-205, Hissar II, female 26-35 year old; Upper right: Sk 33-23-96, Hissar III, male 50+; Lower right: Sk 33-23-107, Hissar III, male 36-50 year old



765 **Figure 5.** Hissar II: Upper: puncture force trauma of left temporal bone near the mastoid
766 process (14 × 14 mm, Sk 33-23-36, male 50+); Lower: sharp force trauma (54 × 12 mm, left
767 parietal bone of Sk 33-23-22, female between 18-25 year old), probable sword or dagger
768 wound with "peeling" of the lateral edge

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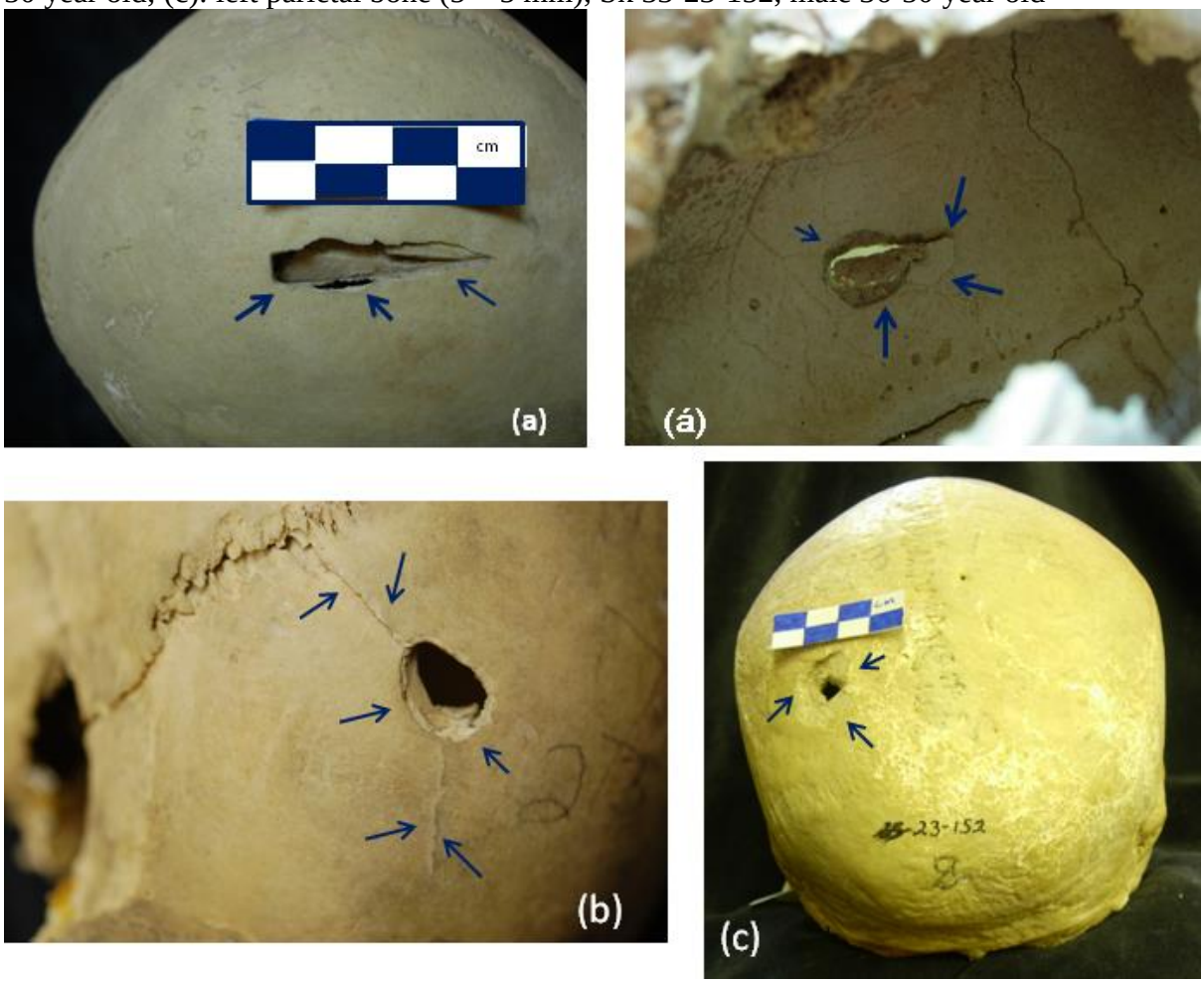
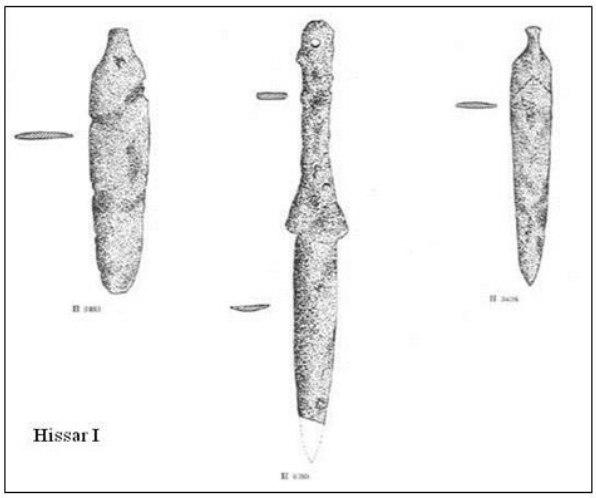
Figure 6. Some examples of perimortem cranial trauma from Hissar III (a, a'): right parietal bone (a:32 ×7 mm) with some parts of bone from the fracture displaced endocranially, Sk 33-23-179, male 36-50 year old; (b): right frontal bone (13 × 7 mm), Sk 33-23-197, female 36-50 year old; (c): left parietal bone (5 × 5 mm), Sk 33-23-152, male 36-50 year old



777 **Figure 7.** Copper dagger and blade from Hissar I (Schmidt, 1937: PL.XVI)



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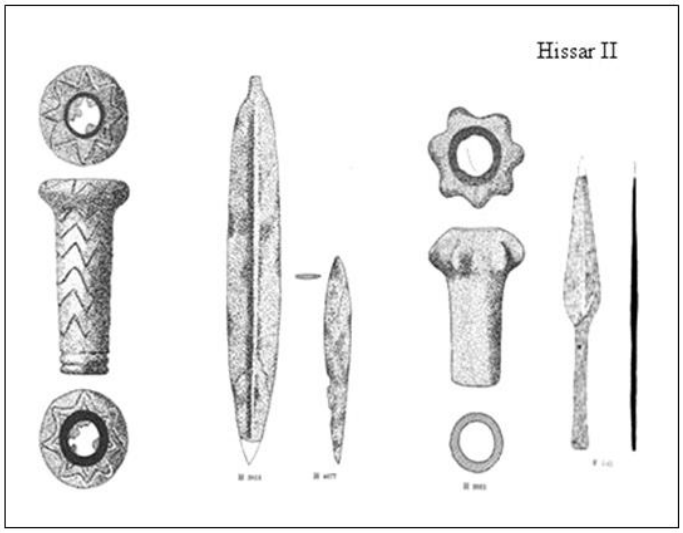
780 **Figure 8.** Copper macehead (left and middle), blade (right), and dagger (middle) from Hissar
781 II (Schmidt, 1933, 1937: PL. CIII, XXIX)



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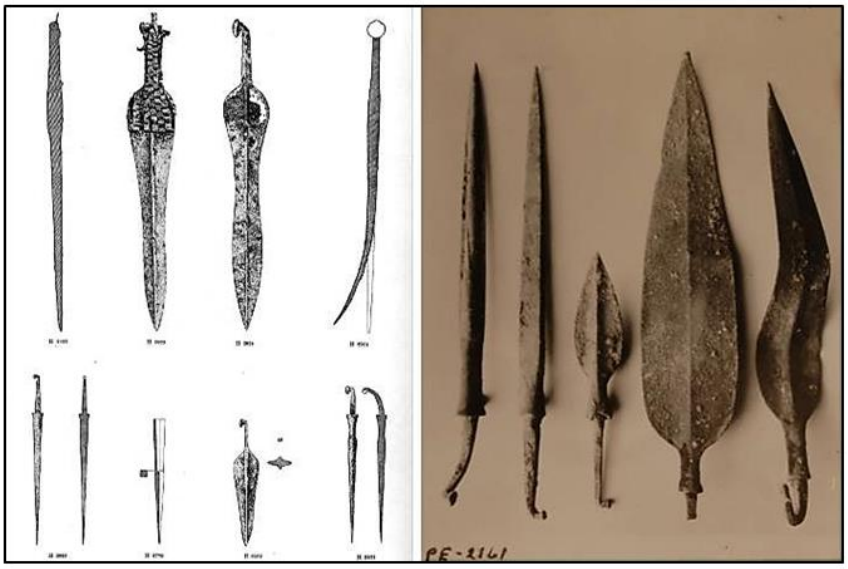
784 **Figure 9.** Examples of copper weapons from Hissar III (left: Schmidt, 1937: Pl.L; right: from
785 Schmidt's Unpublished Archive)



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788 **Figure 10.** Mass burials (Plot DH06, DG00) from Hissar III (from Schmidt's Unpublished
789 Archive)

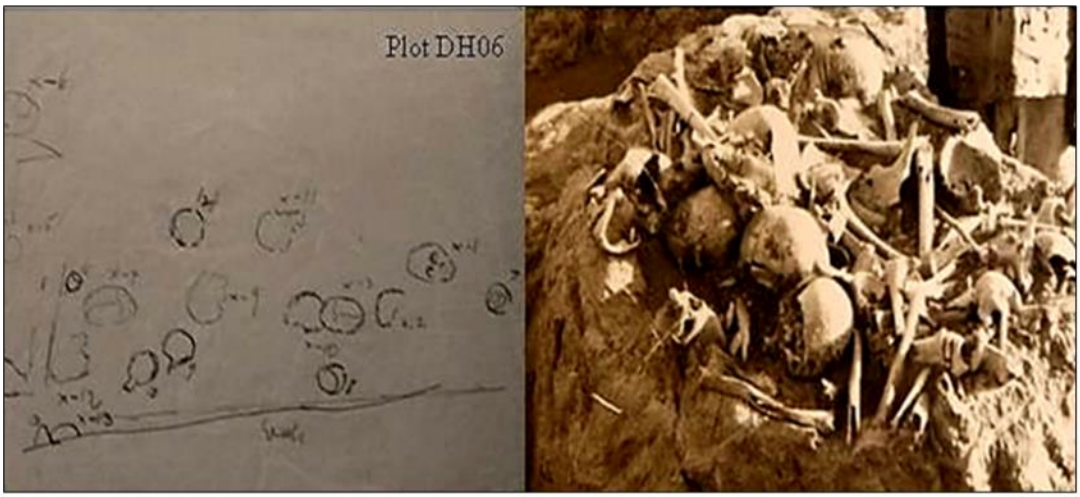

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Figure 11. Burned human skeletal remains from Hissar III

Figure 12. The location of mass burials (red stars) and communal burial (circle) on the plan of Tepe Hissar investigation- black squares (restudy team in 1976), and white squares (Schmidt, 1931-33) (Dyson and Tosi, 1989)

Tables:

Table 1. The chronology of Tepe Hissar **(after** 1.Pollard et al., 2012; 2.Thornton, 2009; 3.Roustaei, 2010)

[1] Period B.C.	Tepe Hissar
Iron Age III 800-550	Hissar Iron Age [3]
Iron Age II 1200-800	Hissar Iron Age [3]
Iron Age I 1550-1200	Hissar Iron Age [3]
Late Bronze Age 1700-1550	?
Middle Bronze Age 2200-1700	Hissar IIIC [2]
Early Bronze II 2900-2200	Hissar IIIA?- IIIB (Burned Building)[2]
Early Bronze I 3400-2900	Hissar IIB
Late Chalcolithic 3700-3400	Hissar IIA
Middle Chalcolithic 4000-3700	Hissar IC
Early Chalcolithic 4300-4000	Hissar IA- IB*

*Without C^{14} dates (Fazeli et al., 2009)

Table 2. The number of male and female individuals in the different age groups studied for each time period

Age category	Hissar I		Hissar II		Hissar III	
	Male (n=1)	Female (n=1)	Male (n=7)	Female (n=10)	Male (n=67)	Female (n=43)
YA 1 (18-25)	1(100%)	1(100%)	-	4(40%)	18(26.9%)	17(39.5%)
YA 2 (26-35)	-	-	5(71.4%)	5(50%)	27(40.3%)	16(37%)
MA (36-50)	-	-	1(14.3%)	1(10%)	19(28.3%)	10(23.2%)
OA 50+	-	-	1(14.3%)	-	3(4.5%)	-

Table 3. Distribution of ante- and perimortem cranial trauma at Tepe Hissar by sex and period

Cranial trauma	Hissar I		Hissar II		Hissar III		Total		
	Male (n=1)	Female (n=1)	Male (n=7)	Female (n=10)	Male (n=67)	Female (n=43)	**Hissar I**	**Hissar II**	**Hissar III**
Perimortem	0(0%)	1(100%)	2(28.6%)	2(20%)	12(17.9%)	8(18.6%)	50%	23.5%	18%
Healing	0(0%)	0(0%)	0(0%)	1(10%)	3(4.5%)	0(0%)	0%	6%	2.7%
Healed	0(0%)	0(0%)	1(14.3%)	2(20%)	18(26.9%)	10(23.2%)	0%	17.6%	25.4%
Total	0(0%)	1(100%)	3(42.9%)	5(50%)	33(49.3%)	18(41.9%)	50%	47%	46%

826 **Table 4.** Distribution of ante- and perimortem cranial trauma at Tepe Hissar by age category and
827 period

Age category	Hissar I		Hissar II		Hissar III	
	Male (n=1)	Female (n=1)	Male (n=7)	Female (n=10)	Male (n=67)	Female (n=43)
Perimortem						
YA 1 (18-25)	-	1/1(100%)	-	1/4(25%)	1/18(5.5%)	2/17(11.8%)
YA 2 (26-35)	-	-	1/5(20%)	1/5(20%)	2/27(7.4%)	2/16(12.5%)
MA (36-50)	-	-	0/1(0%)	0/1(0%)	8/19(42.1%)	4/10(40%)
OA 50+	-	-	1/1(100%)	-	1/3(33.3%)	-
Antemortem (Healed-Healing)						
YA 1 (18-25)	-	-	-	0/4(0%)	2/18(11.1%)	1/17(5.9%)
YA 2 (26-35)	-	-	1/5(20%)	2/5(40%)	9/27(33.3%)	3/16(18.7%)
MA (36-50)	-	-	0/1(0%)	1/1(100%)	8/19(42.1%)	6/10(60%)
OA 50+	-	-	0/1(0%)	-	2/3(66.7%)	-

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830 **Table 5.** Distribution of cranial ante- and perimortem trauma by location of the injury

Location	Hissar I		Hissar II		Hissar III	
	Male (n=1)	Female (n=1)	Male (n=7)	Female (n=10)	Male (n=67)	Female (n=43)
Frontal	-	-	1(14.3%)	2(20%)	3(4.5%)	4(9.3%)
Parietal	-	1(100%)	1(14.3%)	1(10%)	22(32.8%)	12(27.9%)
Occipital	-	-	-	-	-	1(2.3%)
Nasal	-	-	-	-	1(1.5%)	-
Orbital	-	-	-	-	2(3%)	-
>1 cranial injury	-	-	1(14.3%)	2(20%)	6(8.9%)	2(4.6%)

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833 **Table 6.** Distribution of ante- and perimortem cranial trauma at Tepe Hissar by type of force

Periods	Antemortem	Perimortem		
	Blunt	Blunt	Sharp	Puncture
Hissar I	-	1/1 (100%)	0/1 (0%)	0/1 (0%)
Hissar II	4/4 (100%)	2/4 (50%)	1/4 (25%)	1/4 (25%)
Hissar III	31/31(100%)	12/20 (60%)	2/20 (10%)	6/20(30%)

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