Biological profile and 2D/3D morphometric analysis of pre-protohistoric human skeletal remains from Eastern Alps

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Key words
- physical anthropology
- biological profile
- geometric morphometrics
- Eastern Alps

Summary
The research proposes a review of pre-protohistoric human groups from Eastern Alps through qualitative and quantitative analysis of osteological finds. The sample consists of human skeletal remains from several archaeological sites of the Trentino-Alto Adige and covers a broad chronological period between the Upper Paleolithic and Early Bronze Age. The finds are part of the anthropological collection preserved at the MUSE – Museum of Sciences (Trento). Comparisons are represented by European specimens selected from the Howells’ craniometric data set (1995). Through comparative analysis and innovative digital techniques for data processing (laser scanning, 2D / 3D landmark based geometric morphometrics, thin-plate spline, multivariate statistical analysis), we carried out an assessment of the biological profile and morphometric features by examining shape and size variation in the cranial district. Methods adopted, based on the quantification of geometric differences, allowed to estimate the degree of morphological affinity, biological relationships, paleopathology and skeletal features of people who populated the Eastern Alps, shedding new light on the origin of hunters and gatherers, neolithic transition and anatomical features.

Parole chiave
- antropologia fisica
- profilo biologico
- morfometria geometrica
- Alpi Orientali

Riassunto

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1. Introduction

The paper assesses the biological profile and the degree of morphological similarities of pre-protohistoric human groups from Eastern Alps. Human skeletal remains, analysed during the study, come from the archaeological sites of Riparo Dalmeri (Tr), Vatte di Zambana (Tr), La Vela (Tr) and Romagnano-Loc III (Tr).

Previous studies have focused on the age estimation at death and sex diagnosis with a deeper examination of dental microwears (Coppa et al., 1997-99; Villa & Giacobini, 2006). In many cases, the focus was on the osteometric analysis of neo-eolithnic populations (Corrain et al., 1976), instead Aicciati et al. (1990) conducted a preliminary examination of human variability, estimated on a national scale, according to 30 variants described by Berry & Berry (1967). These studies, although relevant from the scientific point of view, require further analysis in light of recent discoveries and the application of updated methods in support of the traditional ones in order to get a better understanding of the Eastern Alps population.

My research is focused on the following aims:
1. To identify distinctive features, injuries and paleopathology of each individual;
2. To recognise associations between different cranial morphologies;
3. To test hypothesis about paleo-mesolithic hunter-gatherers origins and quantify the degree of similarity of human groups between Neolithic and Bronze Age. Thanks to the integration between innovative virtual reality techniques, capable of developing into a digital space various aspects of the anatomy, and methods of multivariate statistical analysis, it was possible to interpret processes of biological variability. The applications of two-dimensional and three-dimensional geometric morphometrics allowed to describe in a repeatable and objective manner, through non-invasive investigations, changes in shape and size of the skeletal structure at regional scale.

Regarding the archaeological context, Riparo Dalmeri is located in Grigno (Tr) at 1240 m. The archaeological site is dated to the end of the Upper Palaeolithic (11,260 BP). It was a seasonal camp for hunting (Dalmeri et al., 1991). Of particular value is the discovery of seven teeth, one of which in a ritual pit, during the 1995 and 2003-2004 excavation campaigns. Vatte di Zambana was excavated in 1968. The site is located along the right side of the Adige Valley. At the level of the cut 10 it was found a burial covered with twenty stones. The Sauveterrian stone industries indicate an anthropic frequentation during the Mesolithic. The excavations at La Vela, between 1960 and 2006, highlighted 15 burials attributable to the Square Mouth Vases Culture of the Middle Neolithic. The individuals were inhumed in stone case or stone fence on the left side, in the retracted position with the head facing north (Pedrotti et al., 1977). In 1970 at Romagnano-Loc III came to light burials largely attributable to children deposited inside a tronco-conical vase (Capitanio, 1973; Perini, 1975). The necropolis dates back to the Early Bronze Age, at the stage of Polada-A Culture.

2. Materials and methods

The sample is composed of six deciduous teeth, five incisors and one first molar (RDQ48M/14, RDQ47/11a, RDQ44M/22, RDQ42M/26c, RDQ45/67, RDQ47/72), found at Riparo Dalmeri (Villa & Giacobini, 2006); an almost complete skeleton (V2a) that can be reported to a Mesolithic primary deposition found at Vatte di Zambana (Corrain et al., 1976); fragmentary human skeletal remains of the Middle Neolithic belonging to two individuals, Vel.R («Rattratto» Corrain et al., 1996) and Vel.02, from the site of La Vela; fragmentary human skeletal remains of the Early Bronze Age from the burial n. 13 of Romagnano-Loc III (Ro.13).

The research was divided into three phases. The first consisted in the use of macro and microscopic methods for the correct assessment of the biological profile. The second related to digital analysis of bone surfaces. In the third phase it was conducted the morphometric study of adults. In this context, it became necessary the extension of the sample with data from literature in order to compare multiple configurations (Tab. 1), for a total of 55 individuals (18F-33M-3N-1ND). Comparisons were represented by european specimens from the W.W. Howells archive (1995). The statistical analysis was aimed at defining and interpreting the results. On Vel.02 and Ro.13 we carried out just a brief description because they were attached to the sediment for exhibition reasons.

The biological profile has been rebuilt employing combined metric and morphological methods. With regard to age estimation and sex diagnosis of adults: Meindl & Lovejoy (1985); Brothwell (1981); Smith (1985); Acśni & Nemeskeri (1970); Buikstra & Ubelaker (1994); Loh & Henneberg (1996); Cattaneo & Grandi (2004). About the stature determination, Olivier et al. (1978), Trotter & Gleser (1952). For juvenile skeletal remains we used macroscopic description criteria of Scott & Turner (1997). The profile of teeth was vectorised and the age calculated according to: Ubelaker (1989); Molnar (1972); Sloukal & Hanakova (1978); Schaeffer et al. (2009).

The biological profile is completed with the evaluation of pathological markers and description of injuries from Fornciari & Giulfra (2003), Orner et al. (2003), Cattaneo & Grandi (2004).

The microscopic analysis has been conducted with Leica M165C with magnifications from 7.3 to 120 X. To better define the range of variation, morphology and measurements were taken using 2D / 3D geometric morphometrics (Bookstein, 1991). The main focus was on the neurocranium as more under genetic control than the post-cranial skeleton, which suffers most from environmental influences. According to the treaty of Martin & Saller (1957) we identified 15 landmarks in frontal view and 16 in lateral view (Fig. 1). These were then typed on two-dimensional images and three-dimensional models with the toolbox TPS of the Stony Brook University (Adams et al., 2002) and the software LANDMARK of the University of Kaiserslautern, Institute for Data Analysis and Visualization (IDAV). 2D models have been standardized on TpsDig, while 3D scans were performed with Laser Scanner Optoma X401. Surfaces were merged and finalized with MeshLab (3D Image Processing; Fig. 1). The morphological analysis was carried out only on V2a and Vel.R, in order to identify convexities and concavities (Meyer et al., 1999).

Concerning the multivariate statistical analysis we used MorphoJ (University of Manchester; Klingenberg, 2011) and PAST (University of Oslo; Hammer, 2001): Procrustes superimposition (Rohlf & Sible, 1990); principal component analysis (PCA), on 15 two-dimensional landmarks in lateral view, to obtain a linear projection of the original variables in a new Cartesian system in which variables were arranged in descending order of variance; geometry of main components using thin-plate spline; degree of similarity and quantification of biological distance by means of matrices (matching-type); standardization with Euclidean matrix and UPGMA algorithm. On weighted Pair-Group Method Using Arithmetic Averages; Sneth & Sokal, 1973).
3. Results

3.1. Macro-microscopic analysis

RDQ48M/14 and RDQ45F/67 (Fig. 2 a-c; Fig. 3 c-d) are upper right first incisors (i1), whereas RDQ47/14a, RDQ44M/22, RDQ42M/26c (Figs. 2, 2 l-q, 3 a-b) upper right second incisors (i2). RDQ47F/72 (Fig. 3 g) is a left lower first molar (m1). All of them are primary teeth. The roots have irregular margins that are interrupted at about 2-3 mm from the collar. The occlusal surface of RDQ48M/14, at the microscopic level, is affected by numerous orthogonal striae with variable depth. RDQ47/14a is distinguished by the presence, on the occlusal surface, of a circular cavity in rounded edges linked to the pulp chamber (Fig. 2 f-i). The hole has a diameter of 1,2 mm. RDQ44M/22, buccally, shows a square-shaped fracture in net margins (2,2x1,9 mm; Fig. 2 n). At the level of the collar an accumulation of tartar (Fig. 2 p) and, mesially, two chipping (grade 2; Fig. 2 o-p). The buccal surface of RDQ47F/72 is characterized by two deep rectilinear and
parallel grooves (Fig. 3 g). Overall, the incisors are attributable to the stage 13 of Ubelaker (7 ± 24), whereas m1 to the stage 16 (10 ± 30). The wear varies from stage 6 of first incisors to stage 7 of second incisors and first molar (Molnar, 1972). If compared with other specimens of the same age, the degree of wear of first incisors is comparable to that of Fum4 (Benazzi et al., 2012), instead it is higher compared to the current average (Tab. 2 b).

The skeleton VZa has been subject to restoration in the past (Fig. 4 a). The skull is ovoid, it has got vertical frontal bone, sharp glabella, protruding brow arches, quadrangular orbits, large nasal cavity (nasal index > 51), left parietal hole and right supraorbital notch. A formation with osteophytic edges, projecting and circumscribed, consists in the lower portion of the right acoustic meatus (Fig. 4 n). The mandible is slender with alveolar resorption in right and left M3, exposure of the pulp chamber in left M1 and M2 and secondary dentine in right M1 and M2 (Fig. 4 f). Right ulna and radius show anomalous latero-medial bending, interosseous margin deformation and flattening of distal ends (Fig. 4 f). The shape of the sciatric notch and the preauricular sulcus assign the skeleton to a female individual (Fig. 4 l-m). The auricular surface of the ileum, characterized by macroporosity and irregular edges, is attributable to the stage 7 of Lovejoy (50-59 years). Also, VZa shows various osteolytic and osteophytic formations on cervical vertebrae (Fig. 4 b-c), left humerus (Fig. 4 g), left ulna and radius (Fig. 4 e). In particular, the proximal epiphysis of the right fibula (Fig. 4 d) is affected by a considerable exostoses (11x19 mm). The height is 152 cm ± 3.72.
Fig. 4 - a-n) VZa: a) frontal view, right view, occipital view, left view (blue areas: restoration); b) fragments of cervical vertebrae; c) atlas; d) right fibula; e) left radius; f) right ulna and radius; g) distal epiphysis of the left humerus; h) distal phalanx; i) lower jaw in left view; l) auricular surface of the ileum and preauricular groove; m) sciatic notch; n) right temporal bone. / a-n) VZa: a) cranio in norma frontale, laterale dx, occipitale, laterale sx (in blu le aree restaurate); b) frammenti vertebre cervicali; c) atlante; d) fibula dx; e) radio sx; f) ulna e radio dx; g) epifisi distale omero sx; h) falange distale; i) mandibola in norma laterale sx; l) superficie auricolare ileo e solco preauricolare; m) incisura ischiatica; n) osso temporale dx.
Tab. 2 - a) MD and BL diameters of RD i1- i2- m1; b) degree of wear (Molnar, 1972) RD-VZa-Vel.R and comparisons (y = years; MPHS = Middle Paleolithic H. sapiens; UPHS = Upper Paleolithic H. sapiens; MESO = Mesolithic; NEO = Neolithic; RHS = Recent H. sapiens). / a) diametri MD e BL in RD i1- i2- m1; b) grado di usura (Molnar, 1972) RD-VZa-Vel.R e confronti (y=anni; MPHS=Middle Paleolithic H. sapiens; UPHS=Upper Paleolithic H. sapiens; MESO=Mesolitico; NEO=Neolitico; RHS=Recent H. sapiens).

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Fig. 5 - a-s) Vel.R: a) skullcap; b) lesion n.3; c) lesion n.2; d) lesion n.9; e) right jawbone; f) right alveolar arch, lingual surface; g) wear of P2-M1-M2; h) distal epiphysis of the humerus; i) left rib; j) T12 vertebra; m) lesion n.7; n) lesion on the right tibia; o) right heel; p) right auricular surface of the ilium; q) 5° left metatarsal; r) right temporal bone; s) thoracic and lumbar vertebrae. / a-s) Vel.R: a) calotta cranica; b) lesione n.3; c) lesione n.2; d) lesione n.9; e) osso mascellare dx; f) arcata alveolare dx, faccia linguale; g) usura P2-M1-M2; h) epifisi distale omero dx; i) costa sx, vista inferiore; j) frammento vertebra T12; m) lesione 7; n) lesione tibia dx; o) calcagno dx; p) superficie auricolare ileo dx; q) 5° metatarsale sx; r) temporale dx; s) vertebre toraciche e lombari.
The neurocranium of Vel.R consists of occipital bone, two parietal bones and right temporal bone. The right parietal bone is covered by a layer of manganese, carbonate and iron oxide. The mastoid appears massive (Fig. 5 f) and periosteal reaction of the alveolar bone associated with periodontal disease. Enthesopathies on the right olecranon fossa (Fig. 5 h), 5th left metatarsal (Fig. 5 q) and marked enthesis on the right heel (Fig. 5 o). The T12 shows a cranio-caudal crushing and, superiorly, an oval osteolytic area with maximum diameter 7,2 mm (Fig. 5 l). The right tibia diaphysis is crossed by a latero-medial longitudinal lesion (17,3 x 4 mm) with sharp margins and bone reaction on the edge (Fig. 5 n). The length of diaphysis indicates that it is a child of about seven months ± 5.

3.2. Digital analysis

The distribution of curvatures of VZa highlighted structures not otherwise visible through the macroscopic examination. At the level of the mandibular condyles there is a massive concentration of pits and porosity with negative values of the histogram above the right condyle (Fig. 7 c). This is characterized by two central grooves (K = 1,20) surrounded by minor depressions (K = 1,18) connected between them by a more superficial circular groove (K = 1,11). On the cranial external plate 10 circular depressions have been identified, with maximum diameters from 11 to 19 mm, localized on the left parietal bone (Fig. 7 a), perfectly aligned, with the same curvature value (K = 1,13). Different appears a further depression located on the right parietal, behind the coronal suture (Fig. 7 b). It has a maximum diameter of 26,9 mm, oval shape and greater curvature factor (K = 1,20).

The skull of Vel.R is characterized by 9 longitudinal lesions (Fig. 8) with partial loss of substance (Fig. 5 b, c, d, m). Variable length (23-45 mm) and almost constant width (3,26 to 3,50 mm). They are partly covered by concretions (Fig. 5 d). The lesion 1 is located in front on the right parietal, at about 11 mm from the sagittal suture and extends to the antero-posterior direction. The same lesion is characterized by two thin incisions (Fig. 5 c) which run parallel to it (K = 1,2). The lesions 2 and 5 are on the left parietal, behind the coronal suture, respectively at 23 and 51 mm from the sagittal suture. The lesions 3 and 4 extend across the left parietal bone, and they are located at about 31 and 33 mm from the sagittal suture. The lesion 7, on the left parietal bone (Fig. 5 m), shows different orientation and periosteal reaction along the edges (length 7,9 mm; K = 1,14).

The lesion 8, at the rear of the previous one, approaches the contour of the sagittal suture assuming a curved shape. The lesion 9 is located on the right parietal bone, at about 10 mm from the sagittal suture and, below, to 6 mm from the lambdoid suture. All lesions, except n. 7, show bone bridges (K = 0,86), irregular base, thin sides, and sharp edges.

The right maxillary is characterized by a proliferation of compact spherical bone placed below the infraorbital edge, width 4,47 and height 2,74 mm (Figs. 5, 8 c-d).

3.3. Morphometry and multivariate statistical analysis

The first incisors show different mesio-distal (MD) and bucco-lingual (BL) diameters (Tab. 2). The measures on RDQ49M/14 are 6,7 mm in MD and 5,2 mm in BL, while RDQ45F/67 has a MD diameter of 6,1 mm and 5,6 mm BL. Second incisors, RDQ47/14a, RDQ44M/22 and RDQ43M/26c, show a significant divergence in MD diameters (respectively 5,5-5,3-5,9 mm) and similar measures in BL (respectively 5,2-5,5-5,1 mm). The first molar RD47F/72 is bigger than recent deciduous specimens (MD = 9,2; BL = 6,1 mm).

Out of 19 specimens from Trento, shown in table 1, the horizontal-cranial index registers a mean value of 75,5 in the Mesolithic increasing progressively up to the Bronze Age (77,3). The vertico-longitudinal i. changes from 75,2 to 69,6 during the Mesolithic and the Bronze Age. The average of the vertico-trasversal i. is 98,7 in the Mesolithic and gradually decreases in the later stages. The nasal i. starts with 50,8 of the Mesolithic and reaches intermediate values between 46,3 and 49,2 in the later stages. Stands the discontinuous trend of the orbital i. with an increase between Eneolithic and Bronze Age (79,2-81,92). Except for the value 49,03 of the Mesolithic, the superior-facial i. remains substantially unchanged (Fig. 9).

The statistics, developed starting from the cranial index of 45 specimens (Tab. 2), detect 56,9% of shared features among individuals of European Paleolithic and Mesolithic of the Eastern Alps. In Trentino - A. Adige between Mesolithic and Neolithic the similarity is 50,8%, while the affinity increase up to 61,4% in the period between Neolithic and Bronze Age.

The PCA, built on 45 individuals according to 15 standard landmarks in lateral view, shows different combinations for 10. For paleo-mesolithic stage, Vette di Zambana and Kauferthberg (Kau) reveal strong morphological affinity (88,2%), while decreases the degree of similarity with respect to peninsular specimens: Grimaldi (61,9%); S. Teodorico II (62,3%); Ortucchio (64,4%). About the Neolithic it is visible

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K=curvature factor. Range: 0.7– 1.2.
Fig. 7 - a-f) VZa: a-b) distribution of curvatures on the skull; c) distribution of curvatures on left and right condyles; d) 3D model of the jaw; e) 3D landmarks; f) grid along the sagittal plane for the positioning of landmarks. / a-f) VZa: a-b) distribuzione delle curvature sul cranio; c) distribuzione delle curvature sui condili sx e dx; d) modello 3D mandibola VZa; e) landmarks 3D; f) griglia lungo il piano sagittale per il posizionamento dei landmarks.

Fig. 8 - a-f) Vel.R: a) skull; b) lesions n. 1-9; c) 3D model, right zygomatic and maxillary; d) 3D vectors of the right jawbone; f) distribution of curvatures, superior and occipital views. / a-f) Vel.R: a) cranio; b) lesioni n. 1-9; c) modello 3D, zigomatico e mascellare dx; d) nuvola di punti e nodi vettoriali del mascellare destro; e-f) distribuzione delle curvature, norme superiore e occipitale.
a clear separation between the series of La Vela and groups from Fornace Cappuccini (FC) and Passo di Corvo (PC). Vel.01, Vel.02, Vel.2-76 show reciprocal matches (86.4%) and with Remedello group (84.2%). In addition, significant distance between eneolithic specimens of Lasino (Co1-Co2) than Vel.01-Vel.02. Regarding the Bronze Age all individuals in the pile-dwelling site of Fiavè (Fi A-B-C-F-H-D) show a close relationship between them (94.9%).

In the thin-plate spline conducted on VZa the main differences, compared to other specimens of the sample, focus on the cranial vault (Fig. 12 b). A direct comparison between VZa and Kau (Fig. 12 c) indicates moderate differences at the level of glabella and occipital protuberance. In the thin-plate spline drawn up on the cranial vault of neo-eneolithic and Bronze Age individuals, differences are limited to the lower portion of the occipital crest (Fig. 12 d). The grids, built on 19 specimens from Trentino – A. Adige (Fig. 11), in frontal and lateral view, denote a progressive expansion of glabellar and occipital portions, height reduction of the cranial vault, narrowing of the minimum frontal width, raising of orbits and nasal cavity.

The final matrix of biological distances (Tab. 4 a-b) can be considered effective for values between 0 and 5 (the 5th stage denotes a high level of similarity between specimens). Within this range fall the following units: VZa-Ort (4.9); VZa-Kau (4.3); Vel.01-Vel.02-Vel2-76 (1.6; 4.5; 4.9); Rem-FiH (4.9); Fi A-B-C-D-F-H (between 2.7 and 4.2); FC-PC (2.12); Qu-Poy (2.85).

Tab. 3 - a) summary of 2D/TPS statistics (six variables and 45 observations); b) percentage of similarity from the Paleolithic to the Bronze Age (N.45); c) percentage of similarity between Mesolithic and Neolithic specimens from Trentino-A. Adige (N.9); d) percentage of similarity from the Neolithic to the Bronze Age (N.14); e) percentage of similarity between European Palaeolithic and Mesolithic specimens from Trentino-A. Adige (N.7). / a) sommario statistiche 2D/TPS su 6 variabili e 45 osservazioni estratte dal campione; b) percentuale similarità dal Paleolitico all’età del Bronzo (N.45); c) percentuale similarità su esemplari trentini tra Mesolitico e Neolitico (N.9); d) percentuale similarità degli esemplari trentini dal Neolitico all’età del Bronzo (N.14); e) percentuale similarità tra esemplari europei del Palaeolitico e trentini del Mesolitico (N.7).

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Fig. 9 - cranial indexes in the Eastern Alps (N.19) and comparison with European Paleolithic. / indici cranici nell’area alpina orientale (N.19) e confronto con Paleolitico europeo.
4. Discussion and conclusions

The results showed differences in morphology and size of RD specimens compatible with the belonging of deciduous teeth to six different individuals. The dental micro-macrousure, similar to those of Fumane 4 of the Middle Paleolithic, but distant compared to current specimens, could reflect a diet rich in leathery foods and a non-food use of dental arches also among children during the Upper Paleolithic. The circular hole on the occlusal surface of RD-Q47/14a is probably due to intentional modifications in accordance with the assumptions of Villa & Giacobini (2006), by reflecting on the possible use of deciduous teeth for ritual and/or ornamental purposes. The particular shape of the root on RDQ42/26c, RDQ45F/67, and RDQ47F/72 presumably refers to the spontaneous

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Fig. 10 - cranial indexes in the Eastern Alps (N.19) and comparison with European Paleolithic. / indici cranici nell’area alpina orientale (N.19) e confronto con Paleolitico europeo.

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Fig. 11 - modifications of the skull from the Mesolithic to the Bronze Age of Eastern Alps in lateral view, 15 landmarks (a) and frontal view, 16 landmarks (b). / modificazioni del distretto cranico dal Mesolitico all’età del Bronzo nell’area alpina orientale in norma laterale, 15 landmarks (a) e norma frontale, 16 landmarks (b).
Macro-microscopic and digital analysis of VZa showed diffuse alterations of an osteoarthritic nature and inflammation of the temporomandibular right joint. The marked wear of left molars and the consumption of the right condyle show an asymmetrical masticatory cycle. This aspect supports the hypothesis about the use of teeth because of the tanning leather procedure (Ortner, 1985), amply attested by the archaeological remains of the Eastern Alps. The depressions of the external cranial surface are post-mortal and can be related to the pressure exerted by the overlying rocks with which the burial had been covered. The perfect alignment denotes a particular care in the arrangement of stones, probably linked to a precise funeral ritual (Vercellotti, 2008; Broglio, 1995). Abnormalities at the level of forearms represent the results of a double fracture of the third-distal right radius and fracture of the left olecranon turned into serrate pseudoarthrosis, in accordance with the description given by Graziani (1976). It is likely that lesions were produced at a young age, but is more difficult to determine if both are connected to the same event. Traumatic injuries in VZa accord well with a lifestyle characterized by intense physical activity typical of Mesolithic groups dedicated to the harvest, fishing and hunting of wild rock goats and deer.

The analysis performed on Vel.R showed characteristics that can be discovered only through direct comparison with other individuals of the same necropolis. Here, failing to provide the full skeletal series, we have been limited to describing the individual case. Bone reactions visible on esocranial lesions demonstrate typical phenomena of tissue that is preparing to the reparation phase. We can suppose that the wounds have been engraved ante-mortem by a mechanical tool with a wide blade, at a short time between each other. The collapse of the T12 appears the result of a fracture of the vertebral body with Schmorl nodule (Lowell, 1997), while the tibia injury appears to have been caused by a sharp instrument when the individual was still alive. Anomalies on the heel could be associated with stress and inflammation of the Achilles tendon due to repeated microtrauma and orthotic iiperflessions. The lesion found in the jawbone is attributable to an osteoma with central nidus surrounded by an extremely compact sclerotic bone reaction (Fornaciari & Giuffra, 2009).

The set of data acquired by geometric morphometric emphasizes the tendency to differentiation of groups from Trentino-A. Adige compared to peninsular groups. Peculiar is the case of vertico-trasversal and orbital indexes that show significant divergences between specimens from Trentino and the rest of the sample. Compared to the average of the Italian peninsula during the paleo-mesolithic period, the pattern of variability of the individual VZa contrasts, especially for its ipscrania, but it is similar to specimens from Bavarian Alps. On the southern slope of the Eastern Alps, during the Mesolithic, it seems settled on a persistence of the anatomical features typical of Paleolithic groups from the Balkans that would have moved along the Danube to the west both north and south of the Alps (Broglio, 1995).

The Neolithic is a period of deep changes not only in the methods of subsistence but also in skeletal morphology. Anthropological results seem to agree with archaeological data about the arrival of new human groups that gradually supplanted the clan settled in rock shelters along the valley during the Mesolithic, on the edge of the Adige Valley basin. Morphological similarities between individuals of the neo-eneolithic stations from Trentino-A. Adige and Bresciane Prealps indicate population movements towards the foothill areas and along valleys by groups having the same origin. The next chronologic phase, Early Bronze Age, testifies homogeneity and a less pronounced internal variability.

The quantitative traits showed a slight antero-posterior expansion of cranium, reduction in height of the vault, moderate lifting of the orbits, the asymmetry of piriform aperture, raising and narrowing of the orbits, the asymmetry of piriform aperture, raising and narrowing...
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Tab. 1 - Sample (Paleo = Paleolithic, Meso = Mesolithic; Neo = Neolithic; Eneo = Eneolithic; Br = Bronze Age; AMHR = Anatomically Modern Human-present). Outgroups: Nu; Za 1-4; Av1. / Campione di studio (Paleo=Paleolitico; Meso=Mesolitico; Neo=Neolitico; Eneo=Eneolitico; Br=età del Bronzo; AMHR=uomo anatomicamente moderno-attuale). Outgroups: Nu; Za 1-4; Av1.

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Tab. 4 - a,b) matrix of biological distances (N.28; Euclidean metric; UPGMA algorithm). / a,b) Matrice delle distanze biologiche (N.28; metrica Euclidea; algoritmo UPGMA.)
of the nasal cavity. More evident changes fall in the Mesolithic-Neolithic transition and appear to be particularly concentrated in particular in orbital and bregmatic areas.

Genetic studies of variability are still ongoing, but early results seem to confirm a general diversification in terms of mitochondrial DNA of the eastern Alpine populations, with a common genetic basis that originated in the Balkans during the Paleolithic and biological differentiation in conjunction with the arrival of farmers from the Middle East between 6,000 and 5,000 BP (Barbujani et al., 2008), these results coincide with the morphological variability observed during this research. However, given the high rate of variability, we are aware that you can get a statistically representative picture of the population only with a large number of specimens. Unfortunately we did not have the possibility to study the morphometry of specimens other than those from the museum’s collection in this occasion. Therefore, a possible development of the research consists in the analysis of more skeletal series from the Trentino-Alto Adige, examining in depth changes observed in the cranial vault and the mechanisms for making them. The CT (Computed Tomography) may allow an assessment of the internal bone structures in order to understand whether the alterations of VZa are attributable to the same traumatic event, while the FEA (Finite Element Analysis) would add information about the biomechanics of the jaw. In addition, a direct comparison between Vel.R and other individuals from the necropolis of La Vela would hypothesize ritual practices, surgical or any episodes of interpersonal violence related to head injuries.

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References


